Clinical Policy Title: Noninvasive positive pressure ventilation in adults

Clinical Policy Number: 07.02.05

Effective Date: January 1, 2015
Initial Review Date: July 18, 2014
Most Recent Review Date: August 17, 2016
Next Review Date: August 2017

Related policies:

CP# 07.01.01 Obstructive sleep apnea

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Coverage policy

Select Health of South Carolina considers the use of noninvasive positive pressure ventilation (NIPPV) to be clinically proven and, therefore, medically necessary when the following general and medical necessity criteria are met:

<table>
<thead>
<tr>
<th>General criteria (ALL criteria must be met)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need for immediate intubation and mechanical ventilation has been excluded.</td>
</tr>
<tr>
<td>Member is fully cooperative (an essential component that excludes agitated, belligerent, claustraphobic, or comatose patients).</td>
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<tr>
<td>Member has no contraindications to noninvasive ventilation, including but not limited to any of the following:</td>
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<tr>
<td>- Hemodynamic instability.</td>
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<td>- Gastrointestinal bleeding.</td>
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<td>- Lacking an intact protective airway reflex.</td>
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<td>- Problems with retained secretions.</td>
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<td>- Recent upper airway surgery.</td>
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<td>- Status epilepticus.</td>
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<tr>
<td>- Respiratory arrest.</td>
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</table>
### General criteria
*(ALL criteria must be met)*

<table>
<thead>
<tr>
<th>NIPPV is delivered using a bilevel positive airway pressure (also called bilevel PAP and BPAP) mode with or without a backup rate feature, depending on the medical necessity criteria as listed below.</th>
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<tbody>
<tr>
<td>All patients started on noninvasive ventilation are monitored closely for signs of ventilatory failure until stabilized, paying attention to vital signs and gas exchange, as well as tolerance, comfort, air leaks, and patient-ventilator interaction.</td>
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</table>

### Medical necessity criteria
*(ONE of the following criteria must be met)*

<table>
<thead>
<tr>
<th>As support for acute hypercapnic respiratory failure (RF) <em>(arterial partial pressure of carbon dioxide $[\text{PaCO}_2] &gt; 50 \text{ mm Hg}$)</em> in persons with either:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Acute cardiogenic pulmonary edema (ACPE).</td>
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<tr>
<td>2. Chronic obstructive pulmonary disease (COPD).</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>As support for acute hypoxemic RF <em>(arterial partial pressure of oxygen $[\text{PaO}_2] &lt; 60 \text{ mm Hg}$ with a normal or low $\text{PaCO}_2$)</em> in high-risk persons after either:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Transplantation in immunocompromised patients.</td>
</tr>
<tr>
<td>2. Abdominal or lung resection surgery.</td>
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</table>

<table>
<thead>
<tr>
<th>To facilitate weaning from invasive mechanical ventilation after early extubation.</th>
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<tr>
<td>To prevent recurrent post-extubation RF in patients at high risk after either:</td>
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<td>1. Transplantation in immunocompromised patients.</td>
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<td>2. Abdominal or lung resection surgery.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>In individuals with stable, severe COPD when criteria 1, 2, and 3 are met:</th>
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<tbody>
<tr>
<td>1. Presence of symptoms of sleep-associated hypoventilation <em>(nocturnal hypoxemia)</em> such as daytime hypersomnolence, excessive fatigue, dyspnea, morning headache, and cognitive dysfunction.</td>
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<tr>
<td>2. Severe COPD indicated by either:</td>
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<tr>
<td>a. A $\text{PaCO}_2 \geq 55 \text{ mm Hg}$, observed while awake and breathing the member's usual fractional inspired oxygen concentration <em>(FiO$_2$).</em></td>
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<tr>
<td>b. A $\text{PaCO}_2$ of 50 to 54 mm Hg and one of the following:</td>
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<tr>
<td>i. Sleep oximetry demonstrates oxygen saturation $\leq 88$ percent for at least five continuous minutes, done while breathing oxygen at two liters per minute <em>(LPM)</em> or the member's usual FiO$_2$, whichever is higher.</td>
</tr>
<tr>
<td>ii. Hospitalization related to recurrent episodes <em>(≥ two hospitalizations in a 12-month period)</em> of hypercapnic RF.</td>
</tr>
<tr>
<td>3. Obstructive sleep apnea (OSA) <em>(and treatment with continuous positive airway pressure [CPAP]</em>) has been considered and ruled out prior to initiating NIPPV.</td>
</tr>
</tbody>
</table>

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 points 1 and 2 above despite at least two months of compliant use *(an average of four hours’ use per 24-hour period)* of a bilevel PAP device without a backup rate feature.

<table>
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<tr>
<th>Support for RF in persons with progressive neuromuscular conditions or severe chest wall deformities who meet criteria 1, 2, and 3:</th>
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</thead>
<tbody>
<tr>
<td>1. Presence of symptoms of sleep-associated hypoventilation <em>(nocturnal hypoxemia)</em>, e.g., daytime hypersomnolence, excessive fatigue, dyspnea, morning headache, and cognitive dysfunction.</td>
</tr>
</tbody>
</table>
Medical necessity criteria  
(ONE of the following criteria must be met)

2. COPD does not contribute significantly to the member's pulmonary limitation.
3. Physiologic criteria (one of the following):
   a. A PaCO$_2$ $\geq$ 45 mm Hg, observed while awake and breathing the member's usual FiO$_2$.
   b. Nocturnal oximetry demonstrating oxygen saturation $\leq$ 88 percent for five consecutive minutes while breathing the member's usual FiO$_2$.
   c. For progressive neuromuscular disease, maximal inspiratory pressure of 60 cm/H$_2$O or forced vital capacity $< 50$ percent predicted.

Support for central sleep apnea related to congestive heart failure when all the following conditions are met:

1. Prior to initiating support, a complete inpatient, attended polysomnogram must be performed documenting the diagnosis of central sleep apnea.
2. Failure to respond to adequate trials of CPAP, adaptive servo ventilation, and oxygen therapies.
3. Bilevel PAP in a spontaneous timed (ST) mode is used to normalize the apnea-hypopnea index (AHI).
4. Significant improvement of sleep-associated hypoventilation is demonstrated with the use of NIPPV device on the settings that will be prescribed for initial use at home, while breathing the member's usual FiO$_2$.

Limitations:

- All other uses of NIPPV are not medically necessary.
- NIPPV should be applied by a trained and experienced team. Considerations that may limit application include staff learning curve and time requirements (nursing and respiratory therapy), as well as potential for delay in definitive therapy (limit trials of therapy).
- For patients with severe COPD with nocturnal hypoxemia, progressive neuromuscular diseases, chest wall deformities, or central sleep apnea, a 60-day trial using NIPPV is considered medically necessary to allow for proper adjustments of the device's settings and patient accommodation to its use and to evaluate patient compliance and benefits.
- Members should be re-evaluated after 60 days to evaluate the continued medical necessity of NIPPV. For establishment of continued medical necessity, the medical records should document that the member has been compliantly using the device (an average of four hours per 24-hour period) and that the member is benefiting from its use.
- Either a heated or non-heated humidifier is considered medically necessary for use with NIPPV.
- This policy excludes NIPPV used in obstructive sleep apnea. See related policy 07.01.01 Obstructive sleep apnea.
- This policy excludes the use of CPAP, noninvasive ventilation in pediatric populations, and noninvasive negative pressure ventilation.

Alternative covered services:

- CPAP.
- Adaptive servo ventilation.
- Oxygen therapy.
- Tracheal intubation with mechanical ventilation.
**Background**

RF is the inability of the respiratory system to perform one or both of its gas exchange functions: oxygenation and ventilation (carbon dioxide elimination). It is classified as either hypoxemic (type 1) or hypercapnic (type 2), and acute, chronic or acute-on-chronic (Soo Hoo 2014). COPD, ACPE and pneumonia are the most common diagnoses associated with acute RF (Walkey 2013).

Signs and symptoms of RF include: shortness of breath; rapid breathing; air hunger; and, in severe cases, cyanosis, confusion and sleepiness (Soo Hoo 2014). However, very significant RF may be present without dramatic signs or symptoms. Arterial blood gas (ABG) measurement is essential to diagnosing RF (Soo Hoo 2014).

The workup of patients in whom RF is suspected typically involves examinations designed to assess the cause and severity of RF (Soo Hoo 2014). Treatment of RF involves improving gas exchange and treating the underlying cause of the failure. Ventilatory support may be needed to improve gas exchange delivered either invasively with intubation or noninvasively with complete or partial control of the breathing cycle (Soo Hoo 2014). Depending on severity, acute RF is usually treated in a controlled environment such as an intensive care unit, whereas chronic, stable RF can be treated at home or at a long-term care facility (Celli 2004).

**Non-invasive ventilation (NIV):**

NIV delivers mechanically-assisted breaths without the need for intubation or surgery to a preset inspiratory pressure value or volume. NIV is used in the management of both acute and chronic RF, in both the home and health care settings. Goals of NIV include reduction in respiratory rate; increase in tidal volume; decrease in dyspnea; reduction in diaphragmatic electromyography (EMG), transdiaphragmatic pressures and work of breathing; and improvement in oxygenation with a reduction in hypercapnia (Soo Hoo 2014).

Advantages of using NIV during treatment of RF are no need for endotracheal intubation or moderate and/or deep sedation and safe initiation or discontinuation as needed. It is associated with few of the nosocomial complications recognized with endotracheal intubation, such as ventilator-associated pneumonia, critical illness-associated weakness, pneumothorax, delirium and infections associated with the invasive monitoring typically required during invasive life support (AHRQ 2012).

Potential disadvantages of noninvasive ventilation include inappropriate delay of the start of mechanical ventilation via endotracheal tube, gastric distention, claustrophobia, pulmonary aspiration and problems associated with prolonged wearing of the facial interface (e.g., nasal congestion, facial reddening, eye irritation or ulceration of the nasal bridge) (AHRQ 2012, Carron 2013). Major complications of NIV such as pneumonia, barotrauma and hemodynamic effects causing hypotension can be life-threatening and strongly correlate with the degree of pulmonary and cardiovascular involvement (Carron 2013).

Two types of NIV are positive-pressure and negative-pressure. Noninvasive negative-pressure ventilation (NINPV) provides ventilatory support using a device that encases the thoracic cage which lowers the pressure surrounding the thorax, creating subatmospheric, vacuum-like pressure around the thorax. The chest wall passively expands and the diaphragm descends, thereby inflating the lungs. Exhalation occurs with passive recoil of the chest wall (Soo Hoo 2014).
NIPPV has supplanted NINPV as the dominant mode of delivery of NIV. NIPPV is a form of mechanical support in which positive pressure delivers a mixture of air and oxygen throughout the respiratory tree via a noninvasive interface. NIPPV can use a variety of interfaces (face mask, nasal mask or plugs, or a helmet) and ventilatory modes (e.g., volume ventilation, pressure support, BPAP, proportional-assist ventilation [PAV] or CPAP). CPAP and BPAP are the two most commonly used modes. Noninvasive devices may be dedicated solely to noninvasive ventilation or capable of providing support through an endotracheal tube or mask. Current models incorporate oxygen blenders for precise delivery of FiO\textsubscript{2} (Soo Hoo 2014, AHRQ 2012).

**Patient selection:**

Use of NIPPV remains highly variable across institutions and geographical regions. Careful selection of patients according to available guidelines and good clinical judgment, taking into account risk factors for NIPPV failure and proper settings and interfaces of ventilator modalities, can greatly reduce NIPPV complications and optimize patient outcomes (Carron 2013).

Absolute contraindications include any condition requiring immediate intubation (Soo Hoo 2014). Such patients need prompt invasive mechanical ventilation that, when postponed, is associated with increased morbidity and mortality. Other contraindications include hemodynamic instability, gastrointestinal bleeding, lack of an intact protective airway reflex, problems with retained secretions, recent upper airway surgery, status epilepticus and potential upper airway obstruction (Soo Hoo 2014). Additionally, NIPPV should not be used in patients suffering from claustrophobia, in respiratory arrest or who are unable to tolerate the device because of agitation or uncooperativeness (Carron 2013).

Successful application of NIPPV requires evaluation on several levels and may involve a trial to select patients with conditions best suited for treatment (Soo Hoo 2014). Evidence-based guidelines have issued criteria to help identify candidates for NIPPV (Keenan 2011, Celli 2004, British Thoracic Society [BTS] 2002):

- Patient cooperation (an essential component that excludes agitated, belligerent or comatose patients).
- Dyspnea (moderate to severe, but short of RF).
- Tachypnea (> 24 breaths/min).
- Increased work of breathing (accessory muscle use, pursed-lips breathing).
- Hypercapnic (decompensated) respiratory acidosis (pH range 7.10-7.35).
- Hypoxemia (PaO\textsubscript{2}/FiO\textsubscript{2} < 200 mm Hg, best in rapidly reversible causes of hypoxemia).

Along with careful patient selection, NIPPV should be applied by a trained and experienced team. Considerations that may limit application include staff learning curve and time requirements (nursing and respiratory therapy) and potential for delay in definitive therapy (limit trials of therapy). All patients started on NIPPV should be monitored closely for signs of NIPPV failure until stabilized, with attention to vital signs and gas exchange, as well as tolerance, comfort, air leaks and patient-ventilator interaction (Carron 2013).

**Searches**

Select Health of South Carolina searched PubMed and the databases of:
• UK National Health Services Centre for Reviews and Dissemination.
• AHRQ Guideline Clearinghouse and evidence-based practice centers.
• The Centers for Medicare & Medicaid Services (CMS).

We conducted searches on July 13, 2016. Search terms were: "noninvasive ventilation" (MeSH), "respiration, artificial/methods" (MeSH), respiratory muscles/physiopathology" (MeSH), and free text terms "cost-effectiveness," “sleep apnea” and "noninvasive positive pressure ventilation."

We included:

- **Systematic reviews**, which pool results from multiple studies to achieve larger sample sizes and greater precision of effect estimation than in smaller primary studies. Systematic reviews use predetermined transparent methods to minimize bias, effectively treating the review as a scientific endeavor, and are thus rated highest in evidence-grading hierarchies.
- **Guidelines based on systematic reviews.**
- **Economic analyses**, such as cost-effectiveness, and benefit or utility studies (but not simple cost studies), reporting both costs and outcomes — sometimes referred to as efficiency studies — which also rank near the top of evidence hierarchies.

**Findings**

We identified 11 systematic reviews and meta-analyses and three cost-effectiveness analyses for this policy. The strongest evidence for the use of NIPPV is in patients with acute RF due to ACPE and exacerbation of moderate to severe COPD using BPAP mode with or without backup. These conditions respond relatively quickly to treatment and represent the hypercapnic and hypoxemic conditions best suited for NIPPV. Other uses of NIPPV supported by lower-quality evidence include facilitating early weaning from invasive mechanical ventilation, preventing recurrent post-extubation RF in those at high risk and providing ventilatory support in persons with neuromuscular disease. Very low-quality evidence supports the limited use of NIPPV in persons with stable, severe RF and in persons with sleep apnea syndromes.

**Initial support for acute RF:**

- **ACPE** — There is sufficient evidence to support the use of NIPPV as initial support for acute RF. Patients with hypercapnic respiratory acidosis may derive the greatest benefit from noninvasive ventilation. For patients with acute RF due to ACPE, NIPPV plus supportive care reduced mortality and intubation rates compared with supportive care alone (AHRQ 2012). BPAP has been studied more rigorously, but direct comparisons of CPAP and BPAP in patients with ACPE show similar efficacy (AHRQ 2012).
- **COPD exacerbation** — There is sufficient evidence to support the use of NIPPV as initial support for acute RF. NIPPV plus usual medical care (UMC) was associated with lower mortality, intubation rates, in-hospital mortality, complication rates and mean length of stay compared with UMC alone (AHRQ 2012, McCurdy 2012). In patients with COPD exacerbation who have failed UMC, the evidence was insufficient to draw conclusions regarding the superiority of NIPPV or invasive mechanical ventilation (McCurdy 2012).
- **Post-operative** — Although additional studies are needed, current evidence supports the limited use of NIPPV for patients with acute hypoxemic RF who are immunocompromised after transplantation or for use after abdominal or lung-resection surgery (AHRQ 2012).
There is insufficient evidence to support the routine use of NIPPV as initial support for acute RF due to any other etiology.

Facilitate early extubation in candidates for weaning from invasive mechanical ventilation:

- There is sufficient evidence to support the use of NIPPV as a bridge support after early extubation. Noninvasive weaning reduces rates of death and pneumonia without increasing the risk of weaning failure or reintubation. Patients with underlying COPD are most likely to benefit from noninvasive ventilation after early extubation (McCurdy 2012, Burns 2014, Lin 2014).
- There is sufficient evidence to support the limited use of NIPPV to facilitate weaning from invasive mechanical ventilation or to prevent recurrent post-extubation RF in those at high risk (e.g., post-transplant and immunocompromised with hypoxemic RF; post-cardiothoracic, specifically lung resection or abdominal surgery) (AHRQ 2012, Olper 2013).

Support for post-extubation acute RF:

- There is insufficient evidence to support the use of NIPPV in patients with established post-extubation RF, as its effectiveness has not been established (McCurdy 2012).

Stable, chronic RF:

- COPD — There is sufficient evidence to support the use of NIPPV in patients with stable, severe COPD. In select patients with stable, severe COPD who have pronounced hypercapnia, NIPPV with long-term oxygen therapy may improve ventilation and dyspnea but is unlikely to improve quality of life (QoL) (COPD Working Group 2012, Shi 2013). Current evidence-based guidelines agree the combination of NIPPV with long-term oxygen therapy may improve survival in a subset of patients, particularly those with pronounced daytime hypercapnia. However, patients with both COPD and obstructive sleep apnea may benefit more from CPAP in terms of survival and risk of hospital admission (GOLD 2014).

- Cystic fibrosis — There is insufficient evidence to support the use of NIPPV in patients with cystic fibrosis. NIPPV has been proposed and studied: 1) as an adjunct to other airway clearance techniques, particularly in those who have difficulty expectorating sputum and where respiratory muscle fatigue or weakness is an issue; and 2) with oxygen as overnight ventilatory support to improve gas exchange during sleep when oxygen alone is insufficient. In a small, single study of patients who experience daytime hypercapnia, use of NIPPV over a six-week period provided benefits over oxygen and room air in terms of exercise tolerance, dyspnea and nocturnal gas exchange. However, the impact of NIPPV on secretion clearance, pulmonary exacerbations and disease progression remains unclear. Longer-term and larger RCTs are needed to confirm these findings (Moran 2013).

Neuromuscular RF:

- There is sufficient evidence to support the use of NIPPV for support for RF in persons with neuromuscular diseases, primarily motor neuron diseases (Radunovic 2013, Annane 2007). The rationale for using NIPPV is to stabilize vital capacity, thus improving gas exchange and sleep quality and helping to maintain ventilatory autonomy for as long as possible. There is
weak but consistent evidence of benefit in survival and in alleviating symptoms of chronic hypoventilation in persons with neuromuscular and chest wall diseases. There is a small but significant survival benefit in persons with motor neuron diseases and an improvement in sleep-related symptoms in a subgroup of persons with amyotrophic lateral sclerosis (ALS) with severe bulbar dysfunction. However, adverse effects have been underreported.

- Evidence-based guidelines recommend offering a trial of NIPPV for all patients with neuromuscular disease who have symptoms of respiratory fatigue (orthopnea) associated with functional respiratory dysfunction (drop in forced vital capacity [FVC]/maximum inspiratory pressure [MIP]) or symptoms of hypoventilation in the presence of hypercapnia or nocturnal oxygen desaturation (Consensus Conference Report 1999, Farrero 2013, National Institute for Health and Clinical Excellence [NICE] 2010):
  - Symptoms (such as fatigue, dyspnea, morning headache, etc.).
  - Physiologic criteria (one of the following):
    - $\text{PaCO}_2 > 45$ mm Hg.
    - Nocturnal oximetry demonstrating oxygen saturation $\leq 88$ percent for five consecutive minutes.
    - For progressive neuromuscular disease, maximal inspiratory pressure of 60 cm/H$_2$O or FVC $< 50$ percent predicted.

- NIPPV should be continued only if symptomatic and/or physiologic improvements are achieved after a trial of therapy.

- Portable respirators designed for life support are recommended. A significant benefit can be observed in patients who use NIPPV for longer than four hours. NIPPV may be needed during exacerbations requiring more time on ventilatory support for patients already on home NIPPV (Farrero 2013).

- When a patient is on more than 12 hours of ventilation, essential equipment should include two respirators and extra batteries and mouthpieces or masks without support on the nasal dorsum, either nasal or nasal-buccal, to prevent pressure sores. In this case, some patients use different ventilatory parameters depending on the interface selected (Farrero 2013).

- In the event NIPPV is not tolerated or contraindicated, some patients may be able to be treated with NINPV (Corrado 2002).

Support for sleep apnea syndromes:

- The primary mode of NIPPV used for sleep apnea syndromes is CPAP (Aurora 2012). We found no systematic reviews for NIPPV other than CPAP for support for sleep apnea syndromes. One evidence-based guideline found there was limited evidence to support using BPAP therapy in a spontaneous timed mode targeted to normalize the AHI in individuals with central sleep apnea syndrome related to CHF only if there is no response to adequate trials of CPAP, adaptive servo ventilation and oxygen therapies (Aurora 2012).

Policy updates:

In 2015, Select Health of South Carolina identified four new systematic reviews and meta-analyses relevant to this policy (Cabrini 2015, Bajaj 2015, Goodacre 2014, Bundchen 2014). Bajaj (2015) confirmed the improved effectiveness of NIV compared to conventional oxygen therapy when used after planned extubation in a medical intensive care unit (ICU) population. There was insufficient evidence to conclude that NIV improved exercise tolerance in patients with HF (Bundchen 2014). Goodacre (2014)
found low to fair quality evidence that pre-hospital CPAP, but not BiPAP, was effective in reducing mortality and intubation rates.

In 2016, we added three new systematic reviews and meta-analyses to this policy (Amado-Rodriguez 2016, Peng 2016, Faria 2015). There was inconclusive evidence to support NIV as an initial ventilator strategy for the treatment of acute RF in patients with hematological disorders, although acute RF in this population is associated with high mortality (Amado-Rodriguez 2016). Peng (2016) and Cabrini (2015) produced conflicting conclusions regarding the use of NIV to facilitate early extubation in persons treated for acute F. A Cochrane review determined NIPPV was more effective than oxygen alone for treating acute RF in persons following upper abdominal surgery based on low quality evidence (Faria 2015). These new findings would not change the conclusions of the initial policy. Therefore, no changes to the policy are warranted at this time.

Summary of clinical evidence:

<table>
<thead>
<tr>
<th>Citation</th>
<th>Content, Methods, Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amado-Rodriguez (2016)</td>
<td>NIV for acute RF in patients with hematological disorders</td>
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<tr>
<td>Key points:</td>
<td>Systematic review and meta-analysis of 13 studies of various types (2,380 total patients).</td>
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<td></td>
<td>Meta-analyses that compensated for significant publication bias and heterogeneity</td>
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<td>showed a significant risk of death after NIV failure compared to initial intubation (relative risk</td>
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<td>[RR], 1.07; 95% confidence interval [CI], 1.00 to 1.14).</td>
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<td>NIV failure may worsen the prognosis, mainly in less severe patients.</td>
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<tr>
<td>Peng (2016)</td>
<td>Early extubation in patients with acute exacerbation of COPD</td>
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<tr>
<td>Key points:</td>
<td>Systematic review and meta-analysis of 17 low- to moderate-quality RCTs (959 total participants).</td>
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<td>Compared with continuous invasive ventilation, early extubation followed by NIV used</td>
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<td>when pulmonary infection is controlled significantly reduced mortality, ventilator-</td>
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<td></td>
<td>associated pneumonia, weaning failures, re-intubations, duration of invasive ventilation,</td>
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<td></td>
<td>total duration of mechanical ventilation, both intensive care unit (ICU) and hospital length of</td>
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<td>stay (LOS), and hospital costs.</td>
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<td></td>
<td>Marked uncertainty in findings due to absence of high-quality evidence and long-term outcomes.</td>
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<td>Well-designed and adequately powered RCTs are required.</td>
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<tr>
<td>Bajaj (2015)</td>
<td>NIV after planned extubation</td>
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<tr>
<td>Key points:</td>
<td>Systematic review of RCTs comparing NIV to conventional oxygen therapy after planned extubation in</td>
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<td>medical ICU.</td>
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<td>Compared to conventional oxygen therapy, NIV significantly decreased re-intubation rate in</td>
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<td>patients with COPD (RR 0.33, 95% CI 0.16 to 0.69, ( I^2 = 0 )) and at high risk for</td>
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<td>extubation failure (RR 0.47, 95% CI 0.32 to 0.70, ( I^2 = 0 )), but not in a mixed medical ICU</td>
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<td>population (RR 0.66, 95% CI 0.25 to 1.73, ( I^2 = 68%).</td>
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<td></td>
<td>Our study confirms the findings of previous reviews.</td>
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<tr>
<td>Cabrini (2015)</td>
<td>Prevention or treatment of acute RF</td>
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<tr>
<td>Key points:</td>
<td>Systematic review and meta-analysis of 78 RCTs.</td>
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<td>NIV reduced mortality (12.6% in the NIV group vs. 17.8% in control arm; RR = 0.73, 95% CI 0.66 to</td>
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<td>0.81; p&lt;0.001; 7,365 total patients) at the longest available follow-up.</td>
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<td>Results suggest NIV reduced mortality when used to treat or prevent acute RF, but not to facilitate</td>
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<td>an earlier extubation.</td>
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<td>Whenever NIV is indicated, an early adoption should be promoted.</td>
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<tr>
<td>Faria (2015)</td>
<td>Key points:</td>
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<td></td>
<td>Systematic review and meta-analysis of 12,380 patients.</td>
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| Cochrane review  
NIPPV for acute RF post-abdominal surgery | - Systematic review and meta-analysis of two RCTs or quasi-RCTs (269 total participants). Very low to low quality with high risk of bias.  
- Compared to oxygen therapy:  
  o CPAP or bilevel NIPPV reduces the rate of tracheal intubation (RR 0.25; 95% CI 0.08 to 0.83) and LOS (mean difference [MD] -1.84 days; 95% CI -3.53 to -0.15), but no difference in mortality or hospital LOS. Insufficient evidence for an effect on anastomotic leakage, pneumonia-related complications, and sepsis or infections.  
  o In one trial (60 participants), bilevel NIPPV may improve blood gas levels and blood pH one hour after the intervention (PaO₂: MD 22.5 mm Hg; 95% CI 17.19 to 27.81; pH: MD 0.06; 95% CI 0.01 to 0.11; PaCO₂: MD -9.8 mm Hg; 95% CI -14.07 to -5.53).  
- No data provided on gastric insufflation, fistulae, pneumothorax, bleeding, skin breakdown, eye irritation, sinus congestion, oronasal drying, and patient-ventilator asynchrony.  
- More good-quality studies are needed to confirm these findings. |
| Bundchen (2014)  
Heart failure | Key points:  
- Systematic review of four low-quality RCTs.  
- A meta-analysis including 18 participants showed NIV prior to the six-minute walk test promoted increased distance (MD 65.29 m, 95% CI 38.80 to 91.78).  
- Results suggest NIV improves short-term exercise tolerance. High uncertainty in findings due to limited number of studies and participants. |
| Burns (2014)  
Cochrane review  
Post-extubation weaning | Key points:  
- Systematic review of 16 RCTs and quasi-RCTs (994 total adults mostly with COPD).  
- Noninvasive weaning vs. invasive weaning reduced mortality (RR 0.53, 95% CI 0.36 to 0.80); weaning failures (RR 0.63, 95% CI 0.42 to 0.96); ventilator-associated pneumonia (RR 0.25, 95% CI 0.15 to 0.43); LOS in the ICU (MD -5.59 d, 95% CI -7.90 to -3.28) and in the hospital (MD -6.04 d, 95% CI -9.22 to -2.87); and total duration of mechanical ventilation (MD -5.64 d, 95% CI -9.50 to -1.77), tracheostomy rates (RR 0.19, 95% CI 0.08 to 0.47), and reintubation (RR 0.65, 95% CI 0.44 to 0.97).  
- Mortality benefits were significantly greater in trials enrolling patients with COPD than in trials enrolling mixed patient populations (RR 0.36 [95% CI 0.24 to 0.56] vs. RR 0.81 [95% CI 0.47 to 1.40]). |
| Goodacre (2014)  
Pre-hospital CPAP or bilevel inspiratory positive airway pressure (BiPAP) in acute RF | Key points:  
- Systematic review, network meta-analysis, and individual patient data meta-analysis of eight low- to fair-quality RCTs and two quasi-RCTs (six CPAP, four BPAP, sample sizes 23 to 207).  
- Compared to baseline care (ill-defined but often supplemental oxygen), pre-hospital CPAP can reduce mortality and intubation rates; the effectiveness of pre-hospital BPAP is uncertain.  
- Comparisons of pre-hospital CPAP to in-hospital NIV are lacking.  
- The network meta-analysis using individual patient-level data and aggregate data suggested that gender was a treatment effect modifier on mortality. |
| Lin (2014)  
Post-extubation weaning | Key points:  
- Meta-analysis of 10 trials (1,382 total adults with COPD): NIV vs. standard medical therapy.  
- Immediate post-extubation with established RF (two trials): no change in reintubation rate (RR 1.02, 95% CI 0.83 to 1.25) and ICU mortality (RR 1.14, 95% CI 0.43 to 3.00).  
- Early application of NIV after extubation (n = 1080) also did not decrease the reintubation
<table>
<thead>
<tr>
<th>Citation</th>
<th>Content, Methods, Recommendations</th>
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</thead>
<tbody>
<tr>
<td>Chiumello (2013)</td>
<td><strong>Key points:</strong></td>
</tr>
</tbody>
</table>
| Acute RF due to chest trauma     | - Systematic review and meta-analysis of 10 low-quality studies (368 total patients).  
- NIV vs. standard care (oxygen therapy and invasive mechanical ventilation): RR 0.26 (95% CI 0.09 to 0.71, p = 0.003).  
- CPAP vs. NIV: no advantage in mortality.  
- NIV significantly increased PaO₂ and reduced intubation rate, the incidence of overall complications, and infections.  |
| Moran (2013)                     | **Key points:**                                                                                                                                                                                                                      |
| Cochrane review                  | - Systematic review of seven RCTs (106 total participants): six RCTs evaluated single-treatment sessions; one evaluated a six-week intervention. Small numbers of participants with high degree of bias.  
- For airway clearance, NIV vs. chest physiotherapy (four RCTs, n = 79): Airway clearance may be easier with NIV and preferred. NIV improved some lung function parameters but effects on sputum expectoration were unclear.  
- For overnight ventilatory support, NIV vs. oxygen or room air (three RCTs, n = 27): no clear differences except that NIV improved exercise performance vs. room air over six weeks.  
- Impact of NIV on pulmonary exacerbations and disease progression remains unclear.  
- Adequately powered, long-term RCTs needed.  |
| Olper (2013)                     | **Key points:**                                                                                                                                                                                                                      |
| Post-extubation weaning          | - Systematic review and meta-analysis of 14 RCTs (1,211 total patients undergoing cardiothoracic surgery).  
- NIV reduced the reintubation rate (RR 0.29; 95% CI, 0.16 to 0.53; P for efficacy < 0.0001; I² = 0), hospital LOS and mortality.  
- Benefits of NIV are more important in patients with ongoing acute RF (RR, 0.25; 95% CI, 0.07 to 0.89) and in those at high risk of developing postoperative pulmonary complications (RR, 0.19; 95% CI, 0.04 to 0.84).  
- Prophylactic use of NIV in patients at low risk showed no significant effect on reintubation rate (RR = 0.42; 95% CI, 0.12 to 1.48) or other outcomes considered except for oxygenation.  
- Large RCTs needed to confirm results.  |
| Radunovic (2013)                 | **Key points:**                                                                                                                                                                                                                      |
| Cochrane review                  | - Systematic review of one RCT (41 total patients) of NIPPV vs. UMC; low risk of bias.  
- Higher median survival with NIPPV versus UMC: 219 days versus 171 days, estimated 95% CI 12 to 91 days, P = 0.0062).  
- NIPPV improves or maintains QoL in persons with ALS and improves sleep-related symptoms in some subgroups who have severe bulbar dysfunction.  
- NIV improved survival and some measures of QoL in subgroups with better bulbar function.  
- Author’s comments: It is unlikely there will be further RCTs of NIV in unselected cohorts of people with ALS. It would be unethical not to offer NIV to all people with ALS who have symptoms of nocturnal hypoventilation. Adverse effects were underreported.  |
| Shi (2013)                       | **Key points:**                                                                                                                                                                                                                      |
| Stable chronic RF in COPD        | - Meta-analysis of 11 RCTs: eight parallel, three crossover design. Overall low quality with |
### Citation | Content, Methods, Recommendations
--- | ---
 | high degree of bias. From parallel RCTs, NIPPV had no effect on 12- or 24-month mortality (odds ratio [OR] 0.82, 95% CI 0.48 to 1.41), FEV\textsubscript{1} (standard mean difference [SMD] 0.20, 95%CI -0.06 to 0.46), maximal inspiratory pressure (SMD 0.01, 95% CI -0.28 to 0.29) or six-minute walk distance (SMD 0.17, 95%CI: -0.16 to 0.50). NIPPV improved PaCO\textsubscript{2} but not PaO\textsubscript{2} in patients with hypercapnia, while neither improved in patients with hypoxia. Inconsistent effect on dyspnea and blood gases.

#### AHRQ (2012)
Acute RF due to any etiology

**Key points:**
- Systematic review of 71 articles (representing 69 RCTs) of NIPPV vs. supportive care or mechanical ventilation in adults with acute RF of any etiology.
- **Strong evidence:** For acute RF due to severe exacerbations of COPD or ACPE, NIPPV plus supportive care reduced mortality and intubation rates compared with supportive care alone.
- BPAP studied more rigorously, but direct comparisons of CPAP and BPAP for ACPE show similar efficacy.
- Although additional studies are needed, current studies support NIPPV for patients with acute RF postoperatively or who are immunocompromised.
- **Weak evidence:** For postoperative care or post-transplant, NIPPV may facilitate weaning from invasive ventilation or prevent recurrent post-extubation RF in those at high risk.
- Limited evidence shows similar treatment effects across different settings and possibly less benefit in trials designed to replicate usual clinical practice.
- Need further studies in less rigorously studied populations (e.g., acute RF in the context of obesity hypoventilation syndrome, acute respiratory distress syndrome, asthma, or interstitial lung disease) and to understand the role of training and effectiveness when part of routine clinical care.

#### COPD Working Group (2012)
Stable chronic RF in severe to very severe COPD

**Key points:**
- Systematic review of eight RCTs and two systematic reviews of NIPPV vs. UMC; five RCTs used nocturnal NIPPV, three RCTs used diurnal NIPPV largely in closely supervised environment; sleep apnea excluded. Very low to low quality.
- In the short term, NIPPV improves ventilation on oxygen gas exchange, CO\textsubscript{2} gas exchange, and exercise tolerance measured using the six-minute walking test but not FEV\textsubscript{1} vs. UMC.
- Over the long-term studies, no effect of NIPPV on mortality, lung function (FEV\textsubscript{1}), exercise tolerance using the six-minute walking test, oxygen gas exchange, or CO\textsubscript{2} gas exchange.
- Qualitative assessment: NIPPV improves dyspnea based on reduced Borg score or Medical Research Council dyspnea score versus UMC but not hospitalizations.
- Health-related quality of life could not be evaluated.

#### McCurdy (2012)
Acute RF in COPD

**Key points:**
- Systematic review of multiple RCTs of very low to moderate quality.
- For first-line treatment of acute RF (11 RCTs, 1,000 total patients), NIPPV + UMC had significantly lower intubation rates, in-hospital mortality, mean LOS, and complication rates than UMC alone.
- NIPPV vs. invasive mechanical ventilation (IMV) after failed UMC (two RCTs, n = 205), insufficient evidence to draw conclusions.
- Compared to weaning with IMV (two RCTs, n = 80), NIPPV significantly reduced mortality, nosocomial pneumonia, and weaning failure, but had non-significant reductions in mean LOS and mean duration of mechanical ventilation.
- Post-extubation from IMV, insufficient evidence to draw conclusions.

#### Annane (2007)

**Key points:**
Citation: Neuromuscular and chest wall disorders

Content, Methods, Recommendations:

- Systematic review of eight RCTs (144 total patients) of any mode of nocturnal mechanical ventilation (NMV): significant heterogeneity.
- NMV improved hypercapnia in the short term (RR 0.37, 95% CI 0.20 to 0.65).
- NMV improved nocturnal mean oxygen saturation (weighted mean difference 5.45%, 95% CI 1.47 to 9.44).
- Weak but consistent evidence suggests NMV alleviated symptoms of chronic hypoventilation in the short term.
- NMV prolonged survival mainly in participants with motor neuron diseases (three small studies).
- With the exception of motor neuron disease, further larger RCTs needed to confirm long-term beneficial effects of nocturnal mechanical ventilation on QoL, morbidity, and mortality; to assess its cost-benefit ratio in neuromuscular and chest wall diseases; and to compare the different types and modes of ventilation.

Glossary

Apnea-hypopnea index (AHI) — 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 two 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 two-hour period (i.e., greater than or equal to 10 events).

Arterial blood gas (ABG) — A measure of the acidity (pH) and the PaO\(_2\) and PaCO\(_2\) in arterial blood. Acute or acute-on-chronic respiratory failure is suspected when PaO\(_2\) < 8.0 kPa (60 mmHg) with or without a PaCO\(_2\) > 6.7 kPa (50 mmHg) while breathing ambient air.

Bicarbonate (HCO\(_3\)) — A chemical (buffer) that keeps the pH of blood from becoming too acidic or too basic.

Bilevel positive airway pressure (BPAP) — A continuous positive airway pressure mode used during noninvasive positive pressure ventilation (see definition below) that delivers preset levels of inspiratory and expiratory positive airway pressure. The pressure is higher when inhaling and falls when exhaling, making it easier to breathe.

Chronic obstructive pulmonary disease (COPD) — A lung condition characterized by slowly progressive obstruction of airflow into or out of the lungs. COPD is often caused by chronic bronchitis, emphysema, or a combination of these.

Dyspnea — Difficulty breathing or breathlessness.

Forced expiratory volume in 1 second (FEV\(_1\)) — A measure of lung function used for COPD severity staging; the amount of air that can be forcibly exhaled from the lungs in the first second of a forced exhalation.

Forced vital capacity (FVC) — The amount of air that can be forcibly exhaled from the lungs after taking the deepest breath possible.
**Fraction of inspired oxygen (FiO₂)** — The percentage of oxygen participating in gas exchange. The member’s usual FiO₂ refers to the oxygen concentration the member normally breathes when not undergoing testing to qualify for coverage of NIPPV. That is, if the member does not normally use supplemental oxygen, their usual FiO₂ is that found in room air.

**Hypercapnia** — Too much carbon dioxide in the blood (arterial blood carbon dioxide > 45 to 60 mm Hg).

**Hypoxemia** — Low arterial blood oxygen levels while breathing air at rest. May be severe (PaO₂ ≤ 55 mm Hg), moderate (56 mm Hg ≤ PaO₂ < 65 mm Hg), or mild to moderate (66 mm Hg < PaO₂ ≤ 74 mm Hg).

**Invasive mechanical ventilation (IMV)** — Mechanical ventilation via an artificial airway (endotracheal tube or tracheostomy tube).

**Noninvasive positive pressure ventilation (NIPPV)** — Noninvasive method of delivering ventilator support (without the use of an endotracheal tube) using positive pressure through a facial or nasal mask to reduce inspiratory work.

**Partial pressure of carbon dioxide (PaCO₂)** — The pressure of carbon dioxide dissolved in arterial blood. This measures how well carbon dioxide is able to move out of the body.

**Partial pressure of oxygen (PaO₂)** — The pressure of oxygen dissolved in the blood. This measures how well oxygen is able to move from the airspace of the lungs into the blood.

**pH** — A measure of hydrogen ions (H+) in blood. Normal pH of blood is usually between 7.35 and 7.45. A pH of less than 7.0 is called acidic and a pH greater than 7.0 is called basic or alkaline.

**Polysomnogram** — 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, defined to include a one- to four-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.

**Respiratory failure (RF)** — The respiratory system cannot sufficiently oxygenate the blood and/or remove carbon dioxide from the blood. It can be either acute, chronic, or acute-on-chronic and is classified as either hypoxemic (type I) or hypercapnic (type II) respiratory failure.

- **Acute hypercapnic RF** — The patient will have no, or minor, evidence of pre-existing respiratory disease and arterial blood gas tensions will show a high PaCO₂, low pH, and normal bicarbonate.
- **Chronic hypercapnic RF** — Evidence of chronic respiratory disease, high PaCO₂, normal pH, and high bicarbonate.
- **Acute-on-chronic hypercapnic RF** — An acute deterioration in an individual with significant pre-existing hypercapnic respiratory failure, high PaCO₂, low pH, and high bicarbonate.
- **Hypoxemic respiratory failure (type I)** — Characterized by a PaO$_2$ < 60 mm Hg with a normal or low PaCO$_2$. This is the most common form of respiratory failure, and it can be associated with virtually all acute diseases of the lung, which generally involve fluid filling or collapse of alveolar units. Some examples of type I respiratory failure are cardiogenic or noncardiogenic pulmonary edema, pneumonia, and pulmonary hemorrhage.

- **Hypercapnic respiratory failure (type II)** — Characterized by a PaCO$_2$ higher than 50 mm Hg. Hypoxemia is common in patients with hypercapnic respiratory failure who are breathing room air. Acute hypercapnic respiratory failure frequently occurs in COPD patients experiencing acute exacerbations of COPD.

**Sleep apnea** — Interruption of breathing during sleep due to obstruction of the airway or alterations in the brain. Associated with excessive daytime sleepiness or disrupted sleep.

- **Central sleep apnea (CSA)** — A sleep disorder in which breathing stops repeatedly when the brain temporarily stops sending signals to the muscles that control breathing. The condition often occurs in people who have certain medical problems.

- **Obstructive sleep apnea** — Repeated episodes of complete or partial blockage of the upper airway during sleep. It is the most common form of sleep apnea.

**References**

**Professional society guidelines/other:**


Peer-reviewed references:


**Clinical trials:**


**CMS National Coverage Determinations (NCDs):**

Local Coverage Determinations (LCDs):

No LCDs identified as of the writing of this policy.

**Commonly submitted codes**

Below are the most commonly submitted codes for the service(s)/item(s) subject to this policy. This is not an exhaustive list of codes. Providers are expected to consult the appropriate coding manuals and bill accordingly.

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<th>CPT Code</th>
<th>Description</th>
<th>Comment</th>
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<tbody>
<tr>
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<td>Bilevel positive airway pressure.</td>
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<table>
<thead>
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<th>ICD-10 Code</th>
<th>Description</th>
<th>Comment</th>
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<td>J96.92</td>
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