Noninvasive Ventilation For Patients In Acute Respiratory Distress: An Update

Abstract

Over the last 20 years, noninvasive ventilation (NIV) strategies have been used with increasing frequency. The ease of use of NIV makes it applicable to patients presenting in a variety of types of respiratory distress. In this review, the physiology of positive pressure ventilation is discussed, including indications, contraindications, and options for mask type and fit. Characteristics of patients who are most likely to benefit from NIV are reviewed, including those in respiratory distress from chronic obstructive pulmonary disease exacerbation and cardiogenic pulmonary edema. The literature for other respiratory pathologies where NIV may be used, such as in asthma exacerbation, pediatric patients, and community-acquired pneumonia, is also reviewed. Controversies and potential future applications of NIV are presented.
**Introduction**

Acute respiratory failure is an emergency that requires a management strategy tailored to the individual patient and to the resources available. Endotracheal intubation is definitive airway management, but it can have complications. In addition, rapid sequence intubation (RSI) requires a degree of preparation and time that might not be available in the acutely distressed patient. For example, important equipment needs assembly, often the clinical environment is not optimal (such as with refractory hypoxia or abnormal anatomy that makes RSI riskier), or the patient has an underlying condition that could lead to further complication as a result of paralysis (such as in acidosis). Ultimately, with RSI there is a level of risk to the patient, both during the initial procedure of induction, sedation, laryngoscopy, and tube delivery, as well as post procedure, with ventilator-associated risks such as pulmonary barotrauma or ventilator-associated pneumonia.

In consideration of risks associated with definitive airway management, noninvasive strategies that include continuous positive airway pressure (CPAP) and bilevel positive airway pressure (BPAP) are viable management options. These techniques provide a “fast-on” intervention that provides more respiratory support than nasal cannula or a conventional face mask. Unlike endotracheal intubation, NIV is not definitive airway management, and the patient must be closely monitored for signs of clinical deterioration. Nonetheless, NIV can improve the patient’s condition sufficiently to either reverse the underlying acute illness or, alternatively, it may serve to safely delay intubation until proper setup is available. In the case of patients who have a “do not intubate” (DNI) directive, NIV may also allow for temporary life-sustaining support while a potentially reversible process is addressed.

NIV was introduced for management of acute respiratory failure in the 1940s, but became a mainstay of respiratory management only in the last 20 years. A multicenter database review over a 15-year study period from 1997 to 2011 showed that first-line NIV use increased from 29% to 42%, and the success rate improved from 69% to 84%. Success was defined as not requiring use of mechanical ventilation and increased patient survival.

A comprehensive understanding of the physiologic benefits of NIV can lead to efficient and clinically appropriate management decisions. As there was an excellent review article by Torres and Radeos published in a 2011 issue of *EM Critical Care,* this review is designed to provide an update of the literature since then, and to offer evolving perspectives on the increasing utilization of NIV in the setting of acute respiratory distress.

---

**Case Presentations**

Just as you are able to sit down for the first time in hours in the ED, a colleague walks by and says, “I don’t know what’s going on with your new patient, but she doesn’t look good.” You hurry to find a frail, elderly woman sitting upright, mouth agape. She is tachypneic, with a respiratory rate of 40 breaths/min, and is using accessory respiratory muscles. According to EMS, her pulse oximetry reading improved from 67% on 2-L nasal cannula to 80% on a 15-L nonrebreather mask. She has virtually no breath sounds on lung auscultation except for occasional faint wheezing. You initiate bilevel noninvasive ventilation (NIV), and inline continuous nebulizer treatments are started. The respiratory therapist suggests endotracheal intubation, and you suspect that extubation in the ICU will be difficult, further along the treatment course. As the respiratory therapist sets the bilevel NIV at a PIP 12 over PEEP 5, she asks you, “What parameters would make you decide to proceed with endotracheal intubation?”

Meanwhile, you are alerted to an EMS arrival in the resuscitation bay. They have brought an obese 60-something-year-old man, who was “found down.” Initial evaluation was remarkable for somnolence with arousal to painful stimuli. He has been unable to provide his name or past medical history. His vital signs are remarkable for a respiratory rate of 10 breaths/min and hypoxia with a SpO₂ in the mid-80s on room air. He has right lower lung basilar crackles. According to EMS, his hypoxia did not improve on a nonrebreather mask, so CPAP was initiated in the field. Since then, his SpO₂ has improved marginally to the high 80s, but he still arouses only to painful stimuli. During your initial assessment, the patient vomits into the NIV mask, aspirates, and his SpO₂ plummets when the face mask is removed. As you scramble to assemble RSI and intubation materials, you wonder if CPAP was contraindicated and if this airway catastrophe could have been prevented.

Mulling over your stressful patient load, you walk to the bedside of a 9-year-old girl with a past medical history of cerebral palsy. Although she is only minimally interactive, she is accompanied by her attentive parents who are deeply involved with her medical care. Her mother looks worried and explains that her daughter “isn’t breathing right” and that she feels warm. The father mentions a history of a worsening cough. On chart review, you note that her restrictive lung disease from underlying cerebral palsy is worsening, and that she now requires BPAP at night. On examination, you see a mentally and developmentally delayed girl with substernal retractions, tachycardia to 125 beats/min, tachypnea to 35 breaths/min, and an oral temperature of 38.3°C (101°F), but she is maintaining an oxygen saturation of 97% on room air. A chest x-ray confirms a right upper lobar pneumonia. The patient shows increased work of breathing, and you wonder if NIV would help.
(See Figure 1.) This leads to airway stenting and elimination of dead space through recruitment of atelectatic alveoli, resulting in increased functional residual capacity and an increase in tidal volumes due to improved lung filling, directly increasing minute ventilation. However, the beneficial effects of PPV are not due simply to pulmonary recruitment. In patients with pulmonary edema due to decompensated heart failure, the impact of PPV may be due more to its hemodynamic effects. PPV increases intrathoracic pressure, and this increase, relative to extrathoracic compartments, can both decrease venous return and increase left heart output. In other words, PPV can decrease both preload and afterload.

In the clinical setting, such as in patients with congestive heart failure, the adjustment of preload, afterload, and redistribution of pulmonary blood flow from alveolar recruitment is what provides symptomatic relief and decrease of pulmonary edema. Finally, PPV decreases the work of breathing by eliminating the patient’s need to overcome airway resistance.

### Critical Appraisal Of The Literature

Searches were conducted through PubMed and OVID Medline for literature from 2010 to 2016. Keywords included noninvasive ventilation, with and without the qualifying inclusion of the term acute respiratory failure, to limit the resources to acute conditions. The search was restricted to studies available in the English language. The references from the articles identified were then searched for additional references, retrieving more than 700 articles. Priority was given to articles addressing commonly occurring emergent medical conditions, with additional special attention given to topics falling under the category of emerging areas of research.

### Types Of Respiratory Failure

Acute or acute-on-chronic respiratory failure can be conceptually divided into 2 major management categories: hypoxic respiratory failure and hypercarbic respiratory failure. Hypoxic respiratory failure is a disease state of inadequate oxygenation, while hypercarbic respiratory failure is due to inadequate ventilation. Management approaches are outlined in Table 1. Clinically, there is often overlap between these 2 types of respiratory failure, such as is seen in chronic obstructive pulmonary disease (COPD) exacerbation.

### Clinical Application Of Noninvasive Ventilation

#### Positive Pressure Ventilation

NIV relies on the creation of positive pressure. Understanding the physiologic pathways involved is crucial to clinical decision-making. Positive pressure ventilation (PPV) applies a consistently positive airway pressure that results in increased laminar flow.

### Table 1. Types Of Respiratory Failure And Their Management Approaches

<table>
<thead>
<tr>
<th>Type of Respiratory Failure</th>
<th>Examples</th>
<th>Management Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypoxic (inadequate oxygenation)</td>
<td>• Pneumonia</td>
<td>• Increase fraction of inspired oxygen</td>
</tr>
<tr>
<td></td>
<td>• Congestive heart failure</td>
<td>• Increase mean airway pressure</td>
</tr>
<tr>
<td></td>
<td>• Interstitial respiratory disease</td>
<td>• Increase peak end-expiratory pressure</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypercarbic (inadequate ventilation)</td>
<td>• Chronic obstructive pulmonary disease</td>
<td>• Increase respiratory rate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Increase tidal volume</td>
</tr>
</tbody>
</table>

![Figure 1. Physiologic Pathway Of Positive Pressure Ventilation](image-url)
Types Of Noninvasive Ventilation

There are 2 main types of NIV—CPAP and BPAP—and understanding the differences is critical for respiratory management of patients. CPAP provides constant delivery of the same fixed positive pressure during both inspiration and expiration, and the resulting alveolar recruitment and hemodynamic effects contribute primarily to increased oxygenation. In comparison, BPAP delivers 2 levels of positive pressure: a lower level during expiration and a higher level during inspiration. The inspiratory positive airway pressure (IPAP) and expiratory positive airway pressure (EPAP) can be adjusted independently. Adjustments to the difference between these 2 pressures, a value referred to as pressure support (or the delta pressure), allows for greater or lesser tidal volumes. Assuming a fixed respiratory rate, the greater the difference between EPAP and IPAP, the greater the minute ventilation, which leads to decreased partial pressure of carbon dioxide, arterial (PaCO₂).

An emergency clinician must understand how to use NIV in the clinical setting. This requires an understanding of NIV settings and equipment, the indications and contraindications for use, and how to appropriately select patients based on their pathology.

Noninvasive Ventilation Settings And Types

Modes

Multiple systematic reviews and randomized controlled trials have demonstrated no significant difference in clinical outcomes between ventilator modes, and most conclude that the decision regarding modes is institution- and resource-dependent.¹⁷,⁸

Pressure Settings

Consider starting CPAP at a pressure of 10 cm H₂O. BPAP can be started at an IPAP of 10 cm H₂O and EPAP of 5 cm H₂O to create pressure support of 5 cm H₂O. The pressure settings should subsequently be titrated based on clinical response, including the patient’s respiratory rate, oxygen saturation, and device tolerance. Based on available clinical evidence, IPAP > 20 cm H₂O is poorly tolerated, may cause gastric insufflation, and is therefore not recommended.⁹

Mask Types

There are several types of masks used for NIV, with each having advantages and disadvantages. Choice of mask should be based on patient factors and indications for NIV. (See Table 2.)

Disposable CPAP Systems

Introduction of the Boussignac CPAP system allows for increased adoption of NIV into the prehospital setting. (See Figure 2, page 5.) It utilizes the direct flow of a simple oxygen source (such as a portable or wall-mounted cylinder) to generate up to 10 cm H₂O CPAP. This is done by creating peak end-expiratory pressure (PEEP) through air turbulence generated by accelerated oxygen flow through the center of the chamber. Several studies have demonstrated similar

---

Table 2. Ventilation Mask Types And Uses

<table>
<thead>
<tr>
<th>Mask Type</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Considerations</th>
</tr>
</thead>
</table>
| Nasal mask and nasal pillow| • Fewer complaints of claustrophobia and facial discomfort  
• Enhanced clearance of oral airway to prevent aspiration events  
• Improved oral hygiene during hospitalization | • Requires the patient’s mouth to remain closed for appropriate pressurization  
• According to Navalesi et al, nasal masks may be less efficacious than full-face mask in lowering of PaCO₂  
(P < .0001)¹⁰ | • Useful in the treatment of obstructive sleep apnea and COPD  
• Patient compliance to keep the mouth closed can be difficult in settings of acute dyspnea or respiratory distress |
| Oronasal mask              | • Most familiar to providers  
• Girault et al showed less NIV failure as compared to nasal mask group¹¹  
(P < .0001) | • Patient may have fit issues if there is facial hair, obesity, abnormal nasal contours, or edentulousness  
• Long-term complications: nasal congestion, mouth dryness, pressure sores, discomfort, agitation | • Recommended first-line strategy in managing respiratory failure |
| Cephalic mask              | • Even distribution of pressure around entire face leads to minimized air leaks and skin injury¹² | • Chacur et al in an RCT did not find significant difference in treatment efficacy when compared with oronasal mask¹³ | • Consider using if the patient is not tolerating traditional oronasal masks, especially for patients with do-not-resuscitate directives¹⁴ |
| Helmet                     | • No specific advantages when compared to other modalities | • Uncommonly encountered in the emergency department | • Conflicting studies and results on efficacy and ability to improve PaCO₂ as compared to other NIV modalities¹⁵,¹⁷ |

Abbreviations: COPD, chronic obstructive pulmonary disease; PaCO₂, partial pressure of carbon dioxide, arterial; NIV, noninvasive ventilation; RCT, randomized controlled trial.

---
efficacy of Boussignac CPAP compared to traditional CPAP and BPAP in both the prehospital and emergency department (ED) settings.18-27

Indications And Contraindications To Noninvasive Ventilation
Unfortunately, no clear consensus exists on the indications for NIV, likely due to heterogeneous etiologies of undifferentiated patients with respiratory distress. Therefore, it is easier to consider it potentially useful in any patient with respiratory distress unless there are contraindications. (See Table 3.) Generally, patients who are at increased risk for aspiration or patients who cannot fit the NIV masks are poor candidates for NIV. In addition, patients should have sufficient mental and physical capacity to protect their airway before NIV is applied.28

Patient Selection Based Upon Underlying Pathology
Undifferentiated Dyspnea In The Prehospital Setting
A 2014 systematic review and meta-analysis by Mal et al included 7 randomized controlled trials comprised of 632 patients. The review demonstrated a significant reduction of in-hospital mortality and need for invasive ventilation when NIV was applied in the prehospital setting.29 (In-hospital mortality: relative risk [RR] 0.58; 95% confidence interval [CI], 0.35 to 0.95; number needed to treat [NNT], 18. Need for invasive ventilation: RR, 0.37; 95% CI, 0.24 to 0.58; NNT, 8.) They concluded that, in the distressed patient with undifferentiated dyspnea who appears likely to require intubation and lacks any contraindications, a trial of NIV was reasonable in the prehospital setting.

Chronic Obstructive Pulmonary Disease Exacerbation
Positive pressure support has been emphatically shown to improve morbidity and mortality in COPD exacerbations. NIV increases tidal volumes leading to increased minute ventilation and decreased respiratory rate, thus leading to a decreased PaCO₂ and increased partial pressure of oxygen, arterial (PaO₂).30 In a 2004 Cochrane review, a meta-analysis of 14 studies showed improvement with NIV through improved symptoms and pulmonary function.31 This review, as well as other studies, also showed decreased rates of intubations and complications (such as barotrauma or neurological events), shorter hospital stays, and decreased hospital costs.32,33 Further study has shown that patients with severe COPD exacerbation, acidic patients, and elderly patients with APACHE II (Acute Physiology and Chronic Health Evaluation II) scores < 29 and Glasgow Coma Scale (GCS) scores > 9, are specific subpopulations that benefit the most from NIV.34,35

Asthma Exacerbation
Although the pathophysiology of asthma differs from that of COPD, NIV remains a component in most asthma treatment pathways. Most of the associated studies are small, but they do show improvement in pulmonary function.36-42 A Cochrane review

Table 3. Absolute And Relative Contraindications To Noninvasive Ventilation

<table>
<thead>
<tr>
<th>Absolute Contraindications</th>
<th>Relative Contraindications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need for immediate endotracheal intubation</td>
<td>Decreased level of consciousness</td>
</tr>
<tr>
<td>Excess respiratory secretions</td>
<td>Hemodynamic instability</td>
</tr>
<tr>
<td>High risk of vomiting and aspiration</td>
<td>Severe hypoxia and/or hypercapnia, PaO₂/FiO₂ ratio of &lt; 200 mm Hg</td>
</tr>
<tr>
<td>Past facial surgery precluding proper mask fit</td>
<td>PaCO₂ &gt; 60 mm Hg</td>
</tr>
<tr>
<td></td>
<td>Poor patient cooperation</td>
</tr>
<tr>
<td></td>
<td>Lack of trained or experienced staff</td>
</tr>
</tbody>
</table>

Abbreviations: FiO₂, fraction of inspired oxygen; PaO₂, partial pressure of oxygen, arterial; PaCO₂, partial pressure of carbon dioxide, arterial.
published in 2012 that included 5 separate trials on the study of NIV in status asthmatics was inconclusive, largely due to small sample size and flaws in methodological design. A separate study performed by Nanchal et al used the Healthcare Cost and Utilization Project National Inpatient Sample database to examine whether NIV contributed to a change in patient outcomes. Despite increasing use of NIV and decreasing rates of invasive mechanical ventilation, hospital stay and adjusted mortality rates in asthma exacerbations remained unchanged.

Cardiogenic Pulmonary Edema
There is high-quality evidence that NIV decreases the need for intubation and improves mortality in acute cardiogenic pulmonary edema, although it is not universally accepted as part of the treatment course. Both CPAP and BPAP are used in this patient population, although CPAP more robustly shows clinical improvement as demonstrated in the 2010 meta-analysis by Weng et al. This meta-analysis included 31 randomized controlled trials and concluded that CPAP reduced mortality and rates of intubation in cardiogenic pulmonary edema. An updated Cochrane review from 2013 by Vital et al involving 32 studies concluded that NIV in cardiogenic pulmonary edema significantly reduced hospital mortality and intubation rates.

Community-Acquired Pneumonia
While antibiotic therapy is the main treatment for patients with community-acquired pneumonia (CAP), other supportive measures, including NIV, have been studied for use in severe cases. Studies have shown NIV significantly reduced the need for intubation and duration of intensive care unit (ICU) stay, but it did not improve mortality. A 2012 Cochrane review of 3 randomized controlled trials concluded that NIV in CAP significantly reduced the rate of intubation, reduced the risk of death in the ICU, and shortened ICU stays when compared to usual care, but NIV did not significantly reduce the rate of hospital mortality or length of stay. Unfortunately, the level of evidence, overall, was found to be weak. Severe illness and lack of improvement in clinical symptoms after 1 hour of NIV use were the strongest predictors of NIV failure.

Interstitial Lung Disease
The use of NIV in patients with interstitial lung disease has not been well established. Patients who progress to respiratory failure requiring mechanical ventilation have a poor prognosis and a mortality rate > 80%. Overall mortality rates remain high, and no benefit to NIV in severe interstitial lung disease has been demonstrated, but in patients with lower disease severity, NIV can be considered as a means to avoid or delay intubation.

Submersion Injury
Submersion injury pathophysiology involves defective alveolar surfactant in alveoli that progresses to alveolar collapse and V/Q (ventilation/perfusion) mismatch. Treatment depends upon symptomatology, but should emphasize respiratory support. Symptomatic patients who have stable mental status can be considered for NIV therapy, as the positive pressure may help to address alveolar collapse and pulmonary edema. However, early intubation is advocated in patients who are severely symptomatic.

Pediatric Patients
Although NIV is well established in the adult population, the data from the pediatric population are sparse and studies often lack large patient enrollment and have issues with design methodology. Additionally, the neonatal indications for NIV are very different from pediatric indications.

In a literature review by Vitaliti et al, the authors conclude that successful NIV application in pediatric patients is based upon careful patient selection, application of the therapy before patient deterioration, good mask fit, and close monitoring.

Clinical Course In The Emergency Department
Once it is decided that NIV is a viable option, the emergency clinician needs to optimize the clinical course and monitor for signs of clinical deterioration and complications. This may require frequent examinations, laboratory tests, and reassessments. A 3-year observational study in France identified 3 factors as early predictors of NIV failure:

1. Respiratory failure that is not acute-on-chronic (eg, pneumonia)
2. Acidosis, with pH < 7.3
3. Severe hypoxemia, assessed after 1 hour on NIV

Interestingly, this study did not find altered mental status at the time of admission or various ventilator parameters as early indicators for NIV failure. A similar correlation between pneumonia, low serum albumin level, and failure of NIV was also made in a 3-year observational prospective study of 176 patients. It is also thought that patients with high intrinsic PEEP, commonly due to air trapping from advanced disease, are likely to fail NIV. This is primarily due to an inability to create enough peak inspiratory pressure to overcome the patient’s intrinsic PEEP. The overarching rule for these patients is to ensure frequent PaCO2 monitoring and early intervention if there is respiratory failure.

Chronic Obstructive Pulmonary Disease
Optimizing treatment of COPD is largely determined by minimizing intrinsic PEEP, work of breath-
Asthma
Although there is a lack of evidence regarding use of NIV in an acute asthma exacerbation, anecdotally, there appears to be positive influence on clinical course, perhaps through decreased work of breathing. A trial of NIV prior to intubation is likely valuable in the management algorithm for those patients, barring absolute contraindications. If the patient does not experience improvement in respiratory status within 1 to 2 hours of use, NIV should be abandoned.

Use of inline nebulizer treatments is also commonly employed while the patient with asthma is receiving NIV. Galindo-Filho et al utilized a gamma camera to determine radio-aerosol pulmonary deposition and extrapolate information on pulmonary function and pulmonary clearance. Although there was no improvement in particle deposition or pulmonary clearance in the NIV group, this same group showed overall improvement in pulmonary function testing.

Cardiogenic Pulmonary Edema
Application of NIV is associated with improved symptoms and oxygen saturation in patients with acute cardiogenic pulmonary edema. An observational study by Carvalho et al recorded statistically significant improvements in respiratory rate, pulse, arterial pH, PaCO$_2$, and peripheral O$_2$ saturation within 1 hour of NIV application, suggesting that early application can dramatically improve respiratory status.

Community-Acquired Pneumonia
Although the data show that NIV may have beneficial application in CAP for medical management, it has not been clearly shown to benefit patients with CAP outside of concomitant COPD. In select patients, NIV can be trialed to improve oxygenation and support ventilation. A randomized controlled trial by Consentini et al demonstrated that patients receiving CPAP reached goal oxygenation more quickly and consistently than those receiving standard therapy.

Clinical Deterioration On Noninvasive Ventilation
Patients requiring NIV in the ED setting are typically critically ill and should be closely observed for decompensation. The emergency clinician should be prepared to troubleshoot the administration of NIV or escalate to endotracheal intubation.

Complications Of Noninvasive Ventilation
As with any modality, there are complications associated with NIV that the emergency clinician must anticipate and be prepared to manage.

Risk Of Aspiration
The use of NIV results in an increased risk for aspiration and gastric insufflation, and the risk is increased if there is fluctuating mental status. Therefore, the clinician must ensure the patient is capable of protecting his airway. Inability to protect the airway is a contraindication for NIV.

Barotrauma
PPV can cause barotrauma leading to pneumothorax from increased airway pressures, although this occurs less frequently with NIV compared to traditional invasive mechanical ventilation. It can be mitigated by closely observing titration of the patient’s pressure support requirements. NIV can also lead to hypotension resulting from increased intrathoracic pressures that cause decrease in cardiac preload.

Cardiac Ischemia
There is concern in the setting of cardiogenic pulmonary edema that NIV may lead to increased risk for cardiac ischemia. Two studies have shown that NIV helped improve oxygenation and respiratory function testing.

Table 4. Signs Of Noninvasive Ventilation Failure

- Vomiting with or without aspiration
- Persistent coughing
- Asynchrony of patient breathing with the NIV machine
- Declining level of consciousness
- Persistent hypoxia despite supplemental oxygen and increasing PEEP
- Hemodynamic instability
- Worsening pH, increasing PaCO$_2$, or decreasing PaO$_2$
- Worsening PaO$_2$/FiO$_2$ ratio

Abbreviations: FiO$_2$, fraction of inspired oxygen; NIV, noninvasive ventilation; PaO$_2$, partial pressure of oxygen, arterial; PaCO$_2$, partial pressure of carbon dioxide, arterial; PEEP, positive end-expiratory pressure.

Clinical Pathway For Managing Patients In Respiratory Distress

Is the patient altered, hemodynamically unstable, producing excessive secretions, or otherwise unable to protect the airway?

YES -> Prepare for RSI, making sure to optimize preoxygenation (Class I)

NO -> Do you suspect an acute exacerbation of COPD or asthma?

NO -> Continue therapy (Class I)

YES -> Is the patient improving with standard medical therapy (albuterol, steroids, etc.)?

NO -> Begin NIV, either CPAP or BPAP, if hypercapnic (COPD: Class I; asthma: Class II)

YES -> Continue therapy (Class I)

Does the patient appear to have pneumonia?

NO -> Start trial of NIV (Class II)

YES -> Is the patient improving with antibiotics and oxygen?

NO -> Start trial of NIV, either CPAP or BPAP (Class I)

YES -> Continue therapy (Class I)

Does the patient appear to have acute cardiogenic pulmonary edema?

NO -> Continue therapy (Class I)

YES -> Is the patient improving with nitrates and oxygen?

NO -> Start trial of NIV, either CPAP or BPAP (Class I)

YES -> Continue therapy (Class I)

Abbreviations: BPAP, bilevel positive airway pressure; COPD, chronic obstructive pulmonary disease; CPAP, continuous positive airway pressure; NIV, noninvasive ventilation; RSI, rapid sequence intubation.

Class Of Evidence Definitions

Each action in the clinical pathways section of Emergency Medicine Practice receives a score based on the following definitions.

Class I
- Always acceptable, safe
- Definitely useful
- Proven in both efficacy and effectiveness

Level of Evidence:
- One or more large prospective studies are present (with rare exceptions)
- High-quality meta-analyses
- Study results consistently positive and compelling

Class II
- Safe, acceptable
- Probably useful

Level of Evidence:
- Generally higher levels of evidence
- Nonrandomized or retrospective studies: historic, cohort, or case control studies
- Less robust randomized controlled trials
- Results consistently positive

Class III
- May be acceptable
- Possibly useful
- Considered optional or alternative treatments

Level of Evidence:
- Generally lower or intermediate levels of evidence
- Case series, animal studies, consensus panels
- Occasionally positive results

Indeterminate
- Continuing area of research
- No recommendations until further research

Level of Evidence:
- Evidence not available
- Higher studies in progress
- Results inconsistent, contradictory
- Results not compelling

This clinical pathway is intended to supplement, rather than substitute for, professional judgment and may be changed depending upon a patient's individual needs. Failure to comply with this pathway does not represent a breach of the standard of care.

Copyright © 2017 EB Medicine. 1-800-249-5770. No part of this publication may be reproduced in any format without written consent of EB Medicine.
Special Circumstances

Acute Lung Injury/Acute Respiratory Distress Syndrome

Despite advances in management, a diagnosis of acute lung injury or acute respiratory distress syndrome portends a high mortality rate. Studies comparing mortality and rates of ventilator-acquired pneumonia associated with NIV versus invasive ventilation have produced mixed findings. A meta-analysis of NIV use in acute lung injury by Agarwal et al advised cautious use of NIV in this high-risk population, as their investigation identified a 50% NIV failure rate, with a 48% intubation rate and 35% mortality.81 A more recent trial by Zhan et al found that the NIV group had a lower rate of intubation compared to controls.82 These authors concluded that use of NIV may be safe in selected patients who are observed carefully.

Do-Not-Intubate Orders And Palliative Care

With the increasing elderly patient population, the ED is caring for more palliative care patients and patients with DNI orders. NIV can be used as respiratory support, especially for patients approaching the end of life who may have a reversible process. Additionally, NIV can also briefly extend time for those in the ED who are waiting for loved ones to arrive.84 Providing comfort is also an important part of palliative care. Nava et al examined the use of NIV in end-of-life treatment. They compared comfort level and need for opioids in patients on NIV versus traditional oxygen through reservoir masks. They showed that patients on NIV required less opioids and, overall, suffered less from dyspnea.2 Patients who have NIV initiated in the ED or during hospitalization show prolonged and improved quality of life, although mortality remains high due to underlying disease processes.85-88

Neuromuscular Respiratory Failure

Respiratory failure is a serious and life-threatening complication for a heterogeneous group of patients with neuromuscular disorders. NIV is most useful in patients who require temporary or intermittent (eg, nighttime) support. A prospective cohort study by Servera et al in 17 patients with neuromuscular respiratory failure found that NIV with mechanical cough assistance successfully averted death and intubation in 79.2% of acute episodes.89 In patients requiring long-term use of intermittent mechanical ventilation, NIV may be useful for preventing or delaying progression of chronic respiratory failure. Bourke et al found that, in patients without severe bulbar dysfunction, NIV improved survival and quality of life.90

Blunt Chest Trauma

Rib fractures, pulmonary contusions, pneumothorax, hemothorax, and flail chest are the injuries most commonly associated with blunt chest trauma.91 Use of NIV in patients with these injuries was first described in 1980 by Uretzky et al in a case study of severe acute respiratory distress syndrome following a blast injury.92 A 2013 systematic review and meta-analysis conducted by Chiumento et al reviewing NIV in patients with blunt chest trauma found that patients treated with NIV versus standard care (defined as oxygen administration or invasive mechanical ventilation) had decreased mortality. Patients treated with NIV also had significantly lower intubation rates, infection rates, and shorter ICU stays.93

Cystic Fibrosis

NIV plays a role in the management of cystic fibrosis by helping to clear secretions and in managing exacerbations. Two Cochrane reviews of current literature on positive expiratory pressure physiotherapy showed that NIV can decrease rates of pulmonary exacerbations in patients with cystic fibrosis.94,95 Studies have also shown that NIV can be a bridge to lung transplantation.96 During treatment of an acute exacerbation, NIV can be helpful to assist with airway obstruction from mucus plugging, but definitive data are relatively sparse.

Controversies And Cutting Edge

Sedation For Noninvasive Ventilation

Sedation for NIV has not been traditionally used, since altered mental status is a contraindication. However, patients in extremis often cannot tolerate NIV due to discomfort from the mask apparatus, claustrophobia, and other sources of anxiety. There
are recent case reports, observational trials, and randomized controlled studies reviewing the utility and safety of sedative medications in improving tolerance of NIV. The most commonly described drug classes include opioids (remifentanil), benzodiazepines (midazolam), and the alpha-2 adrenergic agonist, dexmedetomidine.

Contantin et al evaluated the use of remifentanil as sedation for discomfort/anxiety-related NIV failure. They found continuous infusion of remifentanil was associated with improved NIV tolerance, decreased tachypnea, increased PaO₂/FiO₂, and decreased PaCO₂. Rocco et al reported improved tolerance of NIV and decreased failure rates when using a remifentanil-based sedation regimen in 36 patients initially intolerant of NIV. Both studies concluded that remifentanil for light sedation of a patient in acute respiratory failure may improve the likelihood of successful treatment, without deterioration.

A 2012 study by Huang et al compared dexmedetomidine to midazolam in patients who were poorly tolerating NIV for acute pulmonary edema. The study found that continuous infusion of dexmedetomidine resulted in a greater reduction in percentage rates of NIV failure than midazolam and a prolonged mean time to endotracheal intubation. Conversely, a 2014 randomized controlled trial of early-initiated dexmedetomidine demonstrated no improvement in NIV tolerance over placebo. However, it is notable that this study population was started on sedation regardless of initial tolerance.

Noninvasive Ventilation in Procedural Sedation

Many procedures performed in the ED are painful and require sedation to perform, and patients may develop airway obstruction due to relaxation of the upper airway structures during the sedation. A case report in 2010 by Remick et al described successful use of NIV in a morbidly obese patient with a history of obstructive sleep apnea who underwent sedation for electrical cardioversion of new-onset

---

**Risk Management Pitfalls For Noninvasive Ventilation**

(Continued on page 11)

1. “I wanted to start NIV in the ED, but I did not know the exact etiology of the patient’s respiratory distress.”
   Often, a patient will present to the ED in undifferentiated respiratory distress, but can still benefit from a trial of NIV. However, NIV should not be attempted if the patient meets contraindications, which are detailed in Table 2 (page 4). An emergency clinician should remain vigilant and be ready for mechanical ventilation if the patient does not improve while on NIV.

2. “NIV was started via oronasal mask on the patient with respiratory distress, but I had to stop because he complained of nasal dryness and discomfort.”
   There are many options for mask type and fit. As long as the patient remains stable, other modalities should be tried.

3. “EMS brought a patient to the ED on NIV instead of intubating him. I think they were just novice and were too scared to intubate.”
   It is reasonable to trial NIV in patients in the prehospital setting, and it can reduce in-hospital mortality and the need for invasive ventilation. However, if a patient continues to decompensate, the care team should be prepared for intubation.

4. “I did not consider that the patient could get a pneumothorax while on NIV.”
   PPV can increase the risk of barotrauma, which can lead to pneumothorax from the increased airway pressure. While rates of these events are lower than in mechanical ventilation, it can still happen. This should be a part of the differential diagnosis in an acutely unstable patient on NIV who initially appeared to have been improving clinically.

5. “The patient with the do-not-resuscitate order appeared short of breath, so I treated his air hunger with morphine. Now the family is upset with me because the patient passed away before they could get to the ED. I did not want the patient to suffer any longer.”
   The physician can consider starting NIV while the family is en route to the ED, and it may be a safer treatment for air hunger than opioids. This can provide extra time for family to arrive, which may be part of the patient’s end-of-life goals and the process of dying with dignity. However, NIV should, ideally, only be applied with consent after approval from the patient or their duly appointed medical designee.
Strayer and Caputo published a study of 11 patients with a mean body mass index of 25.8 who were undergoing procedural sedation in the ED in whom NIV was successfully used. The authors noted this was only a feasibility study, and a larger study would be necessary.

**Disposition**

Disposition of a patient on NIV ranges from discharge home, admission for observation, admission to the medical/surgical floor, or admission to the critical care setting. Unfortunately, many hospitals have policies that preclude the patient on NIV from any disposition except for a step-down unit or ICU equivalent. While an ICU setting is ideal for a patient who develops worsening respiratory status requiring intubation, patients on NIV often improve quite rapidly. For stable patients or those with a do-not-resuscitate/do-not-intubate order, application of NIV and admission to the general ward may be appropriate. This requires a conversation with the patient (or his or her surrogate), decision-makers, and the medical team that will assume care.

**Summary**

NIV is a potentially lifesaving and stabilizing means of ventilatory support that has entered the mainstream of daily emergency practice. The ease of application and, at times, the almost immediate relief of respiratory instability can significantly improve the clinical outcome of many patients. Nonetheless, the emergency clinician must remain vigilant, especially with fragile patients, and be prepared to intubate for mechanical ventilation when necessary. Developing expertise in NIV requires understanding of the pathophysiology of PPV and mastering the mechanics of ventilation and oxygenation. This includes knowledge of indications and contraindi-

**Risk Management Pitfalls For Noninvasive Ventilation (Continued from page 10)**

6. “I thought the patient was comfortable and starting to fall asleep. I didn’t think that it was possible to be hypercapnic and go into respiratory failure while on NIV.” NIV is not an advanced airway, and any patient placed on this intervention must be closely monitored for deterioration. Signs of NIV failure include declining level of consciousness, which may be caused by worsening PaCO₂ levels. Serial examinations, blood gas testing, and vital signs are critical for monitoring these patients. Remember that tachypnea and hyperventilation are not the same thing. Patients with rapid, shallow breathing can still accumulate dangerous levels of PaCO₂, and NIV does not guarantee a minimum minute ventilation.

7. “My patient will not stop coughing and her breathing is asynchronous with the NIV machine. I’ll give her opioids to make her more comfortable so that I do not have to intubate her, and she can benefit from NIV.” Care must be taken with patients receiving NIV. If they cannot tolerate it or show signs of NIV failure, then they will require intubation. Coughing and asynchrony are signs of ineffective NIV that may lead to failure. While light sedation can be given while on NIV, it must be done with extreme caution to avoid oversedation that may necessitate emergency intubation.

8. “I know the patient I’m admitting for cellulitis will require ICU admission because he requires BPAP at night.” This is not necessarily true. You should consider discussing with the inpatient care team the optimal disposition for the patient. Not all patients who need NIV will require ICU-level care.

9. “The pediatric patient who presented to the ED in respiratory distress has never been on NIV, so I did not want to start a new therapy in the ED.” Although data are lacking, there is reasonable physiologic rationale to support the use of NIV in the ICU in the pediatric patient population, even without previous use. It may prevent intubation, which is important. It is reasonable to try NIV in conjunction with the pediatric ICU team’s directed care.

10. “The ICU team was upset when I told them that I placed the patient with the asthma exacerbation on NIV. They stated that the exact correlation between NIV use in asthma and physiological improvement is unknown.” While it is true that asthma and COPD are fundamentally different in pathophysiology, they are both obstructive processes and NIV can still be helpful, assuming it does not prevent the physician from intubation if the patient deteriorates. It can also be helpful for preoxygenation prior to intubation for the already-hypoxic patient.
cations of NIV, various mask and fit options, and appropriate patient selection. Most critically, the emergency clinician must recognize symptoms of clinical deterioration in a patient on NIV. The growing literature base and enthusiasm to explore additional applications of NIV in other disease states and clinical settings will likely lead to increased adoption of this intervention.

Case Conclusions

Your first patient was in hypoxic respiratory failure, as evidenced by her low oxygen saturation. Underlying COPD exacerbation was presumed, based upon her physical examination. Your patient had already attempted to physiologically compensate for her respiratory failure with an increased respiratory rate. With BPAP, her tidal volume and mean airway pressure increased. The constant baseline airway pressure led to increased oxygenation. Finally, the mechanical support decreased her work of breathing and prevented full respiratory collapse. You checked on her several times over the first 10 minutes on BPAP, and noted that she was no longer using accessory muscles to breathe, her respiratory rate had decreased to 18, her SpO2 had risen to 96%, and you were able to wean her FiO2. Each time you approached her, she opened her eyes wider, smiled, and nodded her head. You rechecked a VBG and were delighted to see that her pH had risen from 7.2 to 7.3 and her PaCO2 had come down from 79 to 61. There was still work to do, but she was headed in the right direction.

With your second patient, after noting copious vomiting, you decided that it was wise to intubate this still-undifferentiated patient. A physical examination and laboratory tests revealed that the patient was acutely intoxicated. The patient was admitted to the critical care team. The pediatric patient was admitted to the pediatric ICU due to her need for noninvasive ventilator support. As you continued to follow her case over the next several days, you were pleased to learn that, despite a critical case of pneumonia, she never required intubation. Her admitting team was able to balance her need for ventilatory support with an aggressive pulmonary regimen. She was slowly weaned off continuous BPAP. Her altered mental status made this patient higher risk for initiation of NIV, but it was not an absolute contraindication.

Time-And Cost-Effective Strategies

• Immediately implement NIV for patients who arrive to the ED in respiratory distress (particularly from acute exacerbations of COPD), after ensuring the absence of absolute contraindications. (See Table 1, page 3.) This may prevent the need for mechanical intubation.

Risk Management Caveat: Be sure to closely monitor your patient on NIV with persistent respiratory distress. If there is, at any time, evidence of an absolute contraindication, relative contraindication, or signs of NIV failure (see Table 3, page 5), then your patient will require intubation.

• Discuss NIV respiratory management with patients who have DNI orders and/or are considering palliative care. End-of-life discussions are very important in the ED. It is possible that you will encounter patients who are found to have terminal disease presenting with respiratory distress. Patients and their families will appreciate knowing that there are options for ventilatory management that are not invasive and can be easily be applied, removed, or otherwise modified for their situation.

• Use NIV judiciously in patients presenting to the ED with respiratory distress. Anecdotally, early use of NIV within the ED can enable a patient who was critically ill to improve rapidly and avoid an admission to the ICU. This is important to recognize as a potential time- and cost-saving strategy, especially in times of ED overcrowding.

References

Evidence-based medicine requires a critical appraisal of the literature based upon study methodology and number of subjects. Not all references are equally robust. The findings of a large, prospective, randomized, and blinded trial should carry more weight than a case report.

To help the reader judge the strength of each reference, pertinent information about the study is included in bold type following the reference. The most informative references cited in this paper, as determined by the authors, are noted by an asterisk (*) next to the number of the reference.


and meta-analysis. JAMA. 2005;294(24):3124-3130. (Meta-
analyses; 15 studies, 843 patients)
13. Chacur FH, Vilella Felipe LM, Fernandes CG, et al. The total face mask is more comfortable than the oronasal mask in noninvasive ventilation but is not associated with improved outcome. Respiration. 2011;82(5):426-430. (Prospective randomized; 60 patients)


76. Galindo-Filho VC, Brando DC, Ferreira Rde C, et al. Noninvasive ventilation coupled with nebulization during asthma crises: a randomized controlled trial. *Respir Care.* 2013;58(2):241-249. (Randomized controlled; 21 patients)


4. Which NIV mask type might be the best choice in treatment of a patient with obstructive sleep apnea and chronic obstructive pulmonary disease?
   a. Nasal mask and nasal pillow
   b. Oronasal mask
   c. Cephalic mask
   d. Helmet

5. According to the current literature, which subgroups of patients with chronic obstructive pulmonary disease (COPD) exacerbations have increased benefit from NIV?
   a. Those with mild forms of COPD, such as patients who have never been hospitalized
   b. Those with GCS score of ≤ 3
   c. Those with pH > 7.4 at time of therapy
   d. Those with APACHE II score < 29

6. You are treating a 17-year-old asthmatic patient with an acute asthma exacerbation and have decided to try BPAP. While observing the patient, he suddenly begins to vomit. What is the next most appropriate step in management?
   a. Suction the patient and continue albuterol treatments via NIV.
   b. Prepare to intubate the patient.
   c. Increase the IPAP and observe.
   d. Give the patient epinephrine intramuscularly and observe.

7. In which patient scenario would NIV NOT be recommended for trial?
   a. A patient who presents with an asthma exacerbation
   b. A patient who presents with an acute exacerbation of cystic fibrosis
   c. A patient who presents with severely symptomatic submersion injury
   d. A patient with a do-not-intubate order

8. Which of the following is NOT one of the 3 factors found to be predictive of NIV failure?
   a. Altered mental status
   b. Respiratory failure that is not acute-on-chronic
   c. Acidosis with pH < 7.3
   d. Severe hypoxemia
Coming Soon in Emergency Medicine Practice

Sedative Hypnotic Withdrawal Syndrome: Recognition And Treatment

AUTHORS:
Cynthia Santos, MD
Department of Emergency Medicine, Icahn School of Medicine at Mount Sinai, New York, NY

Ruben E. Olmedo, MD, FAAEM
Associate Professor of Emergency Medicine, Director of Division of Toxicology

Sedative hypnotic drugs are commonly used to treat anxiety and insomnia, and include benzodiazepines and barbiturates (gamma-aminobutyric acid [GABA]-ergic agents) as well as gamma-hydroxybutyric acid (GHB), gamma-hydroxybutyrolactone (GBL), baclofen, and ethanol. As the chronic use of these drugs (both for medical and nonmedical reasons) has increased in the United States to near-epidemic proportions, emergency departments are seeing an increase in patients suffering from withdrawal. Many of the same biochemical and neurologic processes involved in alcohol dependence, tolerance, and withdrawal are seen in withdrawal from other GABAergic agents. These withdrawal syndromes can include anxiety, tremor, diaphoresis, palpitations, gastrointestinal upset, and insomnia. With some patients, symptoms may progress to hallucinations, delusions, and delirium. This issue reviews optimal management of withdrawal symptoms based upon the drug causing the withdrawal and the severity of the syndrome. Management of special populations, such as trauma patients, critically ill patients, elderly patients, and patients with cardiovascular disease are also reviewed.
Leverage The Latest Advances In Stroke Care!

*Emergency Stroke Care: Advances And Controversies, Volume I* is a brand-new resource that reviews the latest research, recommendations, and guidelines for the diagnosis and management of stroke.

Andy Jagoda, MD, Medical Director at Mount Sinai, who is recognized nationally for his work in neurological emergencies, describes *Emergency Stroke Care: Advances and Controversies* as “a clinically relevant update on the state of the art in diagnosing and managing transient ischemic attacks (TIAs) and stroke.” Highlights of the book include:

**Acute Stroke:**
- **Expanding opportunities for IV rtPA use in acute stroke:** What is the very latest in expanding the time window? What is its use in minor stroke and rapidly improving stroke symptoms? What are the contraindications for IV rtPA?
- **Update on advanced acute stroke imaging:** What is the latest research on CT, CTA, CT perfusion, and 4D CT? What are the concerns and limitations of multimodality neuroimaging?
- **Endovascular therapies for acute ischemic stroke:** What are the recommendations following the most recent trials on mechanical thrombectomy with stentriever? A full analysis of the latest evidence on this major paradigm shift in stroke care.
- **Update on stroke systems of care:** What are Acute Stroke-Ready Hospitals, and how do they fit into your hospital’s practice? The most current Joint Commission guidelines, and information you need on how stroke certifications affect practice in your ED are covered.

**Transient Ischemic Attack:**
- A review of the latest guidelines from the American Heart Association/American Stroke Association
- What you need to know to diagnose TIA quickly and accurately
- Is the ABCD2 Score still the best risk stratification tool?
- Current evidence on cardiac evaluation in TIA
- Echocardiography, CT, or MRI – which is the best choice for imaging?
- The latest on current therapies: antiplatelet agents, anticoagulants, thrombolysis, and risk-factor control

2 Easy Ways To Order:
1. Go online to [www.ebmedicine.net/NJBXE](http://www.ebmedicine.net/NJBXE)
2. Call 1-800-249-5770 or 678-366-7933

Use Promotion Code: **NJBXE** at checkout
Our latest release, *Emergency Trauma Care: Current Topics And Controversies, Volume II* reviews aspects of emergency trauma care that you manage virtually every day. You’ll learn about 6 of the most pressing concerns facing emergency clinicians today, including:

- Treating Pain In Trauma
- Geriatric Trauma
- Obese Patients
- Trauma Malpractice - Tips For Avoiding Risks
- Sports Injuries
- Ballistic Injuries

In addition to our distinguished authors’ discussions, we have included pertinent commentaries on each topic from the emergency medical services, research, surgical, legal, economic, and nursing perspectives—in an effort to give a view of all aspects of trauma care.

Included in this book:
1. 80 pages of evidence-based content, covering 6 high-impact topics
2. 18 AMA PRA Category 1 Credits™ that are trauma specific
3. Summarized information to help you keep up with current guidelines and best practices
4. Treatment recommendations to help you determine the critical actions required when caring for these patients
5. And much more!

**2 Easy Ways To Order:**
1. Go online to: www.ebmedicine.net/NJBXD
2. Call 1-800-249-5770 or 678-366-7933

*Use Promotion Code: NJBXD at checkout*
In upcoming issues of *Emergency Medicine Practice*....

- Maxillofacial Trauma
- Sedative/Hypnotic Withdrawal
- Lower Extremity Dislocations
- Decompensated Heart Failure
- Spontaneous Bacterial Peritonitis
- Renal and Genitourinary Trauma
- Adrenal Crisis

**Physician CME Information**

**Date of Original Release:** February 1, 2017. Date of most recent review: January 10, 2017. Termination date: February 1, 2020.

**Accreditation:** EB Medicine is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians. This activity has been planned and implemented in accordance with the accreditation requirements and policies of the ACCME.

**Credit Designation:** EB Medicine designates this enduring material for a maximum of 4 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

**ACEP Accreditation:** Emergency Medicine Practice is approved by the American College of Emergency Physicians for 48 hours of ACEP Category 1 credit per annual subscription.

**AAFP Accreditation:** This Medical Journal activity, *Emergency Medicine Practice*, has been reviewed and is acceptable for up to 48 Prescribed credits by the American Academy of Family Physicians per year. AAFP accreditation begins July 1, 2016. Term of approval is for one year from this date. Each issue is approved for 4 Prescribed credits. Credit may be claimed for one year from the date of each issue. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

**AOA Accreditation:** *Emergency Medicine Practice* is eligible for up to 48 American Osteopathic Association Category 2-A or 2-B credit hours per year.

**Needs Assessment:** The need for this educational activity was determined by survey of medical staff, including the editorial board of this publication; review of morbidity and mortality data from the CDC, AHA, NCHS, and ACEP; and evaluation of prior activities for emergency physicians.

**Target Audience:** This enduring material is designed for emergency medicine physicians, physician assistants, nurse practitioners, and residents.

**Goals:** Upon completion of this activity, you should be able to: (1) demonstrate medical decision-making based on the strongest clinical evidence; (2) cost-effectively diagnose and treat the most critical presentations; and (3) describe the most common medicolegal pitfalls for each topic covered.

**Objectives:** Upon completion of this article, you should be able to: (1) list the contraindications to use of NIV; (2) identify patients with respiratory failure who may benefit from NIV; (3) describe the various modes of ventilation; and (4) describe treatment of NIV failure.

**Discussion of Investigational Information:** As part of the journal, faculty may be presenting investigational information about pharmaceutical products that is outside Food and Drug Administration–approved labeling. Information presented as part of this activity is intended solely as continuing medical education and is not intended to promote off-label use of any pharmaceutical product.

**Faculty Disclosure:** It is the policy of EB Medicine to ensure objectivity, balance, independence, transparency, and scientific rigor in all CME-sponsored educational activities. All faculty participating in the planning or implementation of a sponsored activity are expected to disclose to the audience any relevant financial relationships and to assist in resolving any conflict of interest that may arise from the relationship. In compliance with all ACCME Essentials, Standards, and Guidelines, all faculty for this CME activity were asked to complete a full disclosure statement. The information received is as follows: Dr. Joshi, Dr. Estes, Dr. Shipley, Dr. Lee, Dr. Littell, Dr. Walsh, Dr. Damilini, Dr. Toscano, Dr. Jagoda, and their related parties report no significant financial interest or other relationship with the manufacturer(s) of any commercial product(s) discussed in this educational presentation.

**Commercial Support:** This issue of *Emergency Medicine Practice* did not receive any commercial support.

**Earning Credit: Two Convenient Methods:** (1) Go online to www.ebmedicine.net/CME and click on the title of the article. (2) Mail or fax the CME Answer And Evaluation Form (included with your June and December issues) to EB Medicine.

**Hardware/Software Requirements:** You will need a Macintosh or PC to access the online archived articles and CME testing.

**Additional Policies:** For additional policies, including our statement of conflict of interest, source of funding, statement of informed consent, and statement of human and animal rights, visit www.ebmedicine.net/policies.

**Direct all inquiries to:**
**EB Medicine**
Phone: 1-800-249-5770 or 1-678-366-7933
Fax: 1-770-500-1316
5550 Triangle Parkway, Suite 150
Norcross, GA 30092
E-mail: ebm@ebmedicine.net
Website: www.ebmedicine.net
To write a letter to the editor, please email: jagodamd@ebmedicine.net

**Subscription Information**

**Full annual subscription:** $349 (includes 12 monthly evidence-based print issues; 48 AMA PRA Category 1 Credits™, 48 ACEP Category I credits, 48 AAFP Prescribed credits, and 48 AOA Category 2A or 2B CME credits. Call 1-800-249-5770 or go to www.ebmedicine.net/subscriptions to subscribe.)

**Individual issues:** $39 (includes 4 CME credits). Call 1-800-249-5770 or go to www.ebmedicine.net/EMPissues to order.

**Group subscriptions at discounted rates are also available.** Contact groups@ebmedicine.net for more information.