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## Noninvasive Positive Pressure Ventilation

### Testing the Bridge

**P**atients with preexisting problems like COPD and neuromuscular problems, or newly developed conditions like overwhelming pneumonia and acute pulmonary edema may decompensate and develop acute respiratory failure. Such patients may need assistance with their ventilation while their underlying acute or exacerbating problems are managed by other medical means. Mechanical ventilation in these cases acts as a bridge to recovery and a return to their baseline status. Traditionally, an endotracheal tube is inserted into the trachea to deliver oxygen under positive pressure to the patient's lungs. On the other hand, the alveolar ventilation can be augmented noninvasively by external negative pressure, chest wall oscillations, or positive pressure ventilation administered through a tight-fitting facial or nasal mask (noninvasive positive pressure ventilation [NIPPV]).<sup>1</sup>

Numerous studies have shown noninvasive ventilation (NIV) to be useful in chronic respiratory failure secondary to conditions such as muscular dystrophies and multiple sclerosis.<sup>2-4</sup> It has also been found to be useful in hypoventilation associated with severe chest wall deformity, central disorders,

obesity/hypoventilation syndrome, and obstructive sleep apnea syndrome.<sup>5</sup> Although the efficacy of NIV in most cases of severe, stable COPD has not been proven, the subgroup of patients with severe hypercarbia has been shown to benefit from NIV.<sup>6,7</sup> COPD patients who have severe nocturnal oxygen desaturation may also benefit from NIV.<sup>8</sup>

Interest in the use of NIPPV for cases of acute respiratory failure has increased in the recent past due to the availability of better-tolerated nasal masks, but the main advantages are the convenience and lower cost of NIPPV and the avoidance of the morbidity and complications associated with intubation. The indications of NIPPV are the same as those for invasive ventilation with tracheal intubation, but there are situations in which NIPPV cannot be used. Respiratory arrest, cardiorespiratory instability, uncooperative patient, high aspiration risk, inability to protect the airways, and fixed anatomic abnormalities of the nasopharynx are considered contraindications.<sup>9</sup> Extreme anxiety, massive obesity, and copious secretions also make a patient unsuitable for the use of NIPPV. Various studies have provided evidence for the efficacy of NIPPV in acute exacerbations of COPD. The benefits have included the following: (1) a significant decrease in the rate of intubation by approximately 66% in NIPPV patients when compared to controls receiving conventional care<sup>10-12</sup>; (2) a significant decrease in mortality (9% vs 29%)<sup>10</sup>; (3) a significant decrease in the ICU length of stay (13 vs 32 days)<sup>11</sup>; and (4) a significant decrease in the hospital length of stay (23 vs 35 days).<sup>10</sup> However, the results of these studies cannot be generalized, and NIPPV is useful only in selected cases.<sup>13</sup> In one of the studies, only 31% of COPD patients were ultimately randomized.<sup>10</sup> This means that there are only a small number of patients who fall in that intermediate zone where NIPPV can be tried; patients who are very ill or have other conditions that make them unsuitable for NIPPV get intubated immediately, whereas others who do not need assistance with their ventilation can be managed successfully with conservative methods. But then, not all patients who are placed on NIPPV do well: in one study, 31% of patients who were initially started on NIPPV required intubation for various reasons after an average of 15 ± 7 h.<sup>14</sup> It is important, therefore, to select suitable cases for NIPPV as promptly and as accurately as possible, so that there is no undue delay in the intubation if it is eventually required. Can we predict the cases in which NIPPV will succeed? Committed caregivers and a cooperative patient are the prerequisites for any NIPPV trial. The chances of success are dictated by some factors that can be identified before the trial is begun. For example, it has been shown that patients who did not respond

had higher  $\text{PaCO}_2$  at entrance ( $91.5 \text{ mm Hg} \pm 4.2$  vs  $80 \text{ mm Hg} \pm 1.5$ ;  $p < 0.01$ ).<sup>15</sup> In the study by Bott et al,<sup>16</sup> the patients who died were more acidotic on admission than the patients who survived (pH, 7.31 vs 7.35, respectively), and they were more hypercapnic ( $\text{PaCO}_2$ , 9.4 kPa [70.5 mm Hg] vs 8.4 kPa [63 mm Hg], respectively), although both groups were equally hypoxic ( $\text{PaO}_2$ , 5.1 kPa [38.3 mm Hg] vs 5.3 kPa [39.8 mm Hg], respectively). In the study by Soo Hoo et al,<sup>17</sup> unsuccessfully treated patients had a greater severity of illness as indicated by the acute physiology and chronic health evaluation II score (mean  $\pm$  SD,  $21 \pm 4$  vs  $15 \pm 4$ ;  $p = 0.02$ ), they were edentulous, and they had pneumonia or excess secretions and pursed-lip breathing, both of which may lead to large mouth leak. Ambrosino et al<sup>18</sup> found that pneumonia was the cause of respiratory failure in 38% of unsuccessful episodes but only in 9% of the successful episodes of NIV. They also found that the logistic analysis of various factors suggested that only pH had a significant predictive value, with a sensitivity of 97% and a specificity of 71%. Once the patient has been placed on NIPPV, certain parameters predict a successful outcome. For example, a more rapid decrease in  $\text{PaCO}_2$  or pH within 1 to 2 h of NIPPV predicted a successful outcome.<sup>15,17,19</sup> Successfully treated patients usually have rapid relief of dyspnea with corresponding reduction in tachypnea and respiratory distress. In this issue of *CHEST* (see page 828), Anton and colleagues have reported the results of their study regarding the factors related to the success of NIV in acute severe exacerbations of COPD. In the first part of their study, 44 episodes of acute respiratory failure were treated by NIV, which was successful in 77% episodes. The patients in whom NIV was successful had a lower  $\text{FEV}_1$  prior to admission, a more favorable level of consciousness, and significant improvement in  $\text{PaCO}_2$ , pH, and level of consciousness after 1 h of NIV. The researchers derived a regression equation that included baseline  $\text{FEV}_1$  and  $\text{PaCO}_2$  under stable condition; initial pH,  $\text{PaCO}_2$ , and level of consciousness; and a change in  $\text{PaCO}_2$  with NIV. The model correctly classified 95.45% of the initial 34 patients with a sensitivity of 0.97 and a specificity of 0.9 when the cut-off was set at 0.5. One rather surprising finding was that those patients who had a lower baseline  $\text{FEV}_1$  responded better to NIV, the cause of which is not clear. There was, however, no difference in the bronchodilator response in stable condition between the patients who succeeded on NIV compared to those who failed. The regression equation uses six different parameters, including the baseline  $\text{FEV}_1$  and  $\text{PaCO}_2$ , that may not be available at all or not obtainable from older records at the time of admission. One of the parameters for calculating

the "level of consciousness score" that the authors have used is flapping tremor, which may not be elicitable in all cases.

We do not yet have an easy or a perfect predictor for the success of NIPPV in acute respiratory failure of COPD. From the previous experience, though, it appears that a conscious, cooperative patient whose respiratory failure was not precipitated by pneumonia, who is neither edentulous nor using pursed-lip breathing, who does not have excessive secretions, and whose arterial blood gas shows a pH  $>$  7.31, would be able to cross the bridge of NIPPV with the help of a caring and committed team of caregivers.

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## Toward a More Thoughtful Approach to Fever in Critically Ill Patients

In this issue of *CHEST* (see page 855), Dr. Paul Marik presents a clinical approach to fever in critically ill patients. This concise review reiterates that all fevers are not necessarily caused by infections and presents a reasonable, albeit not evidence-based, algorithm for approaching this common clinical problem. At some hospitals, intensivists and infectious disease physicians may differ in their general approaches to fever in the ICU. There appears to be a pervasive notion that intensivists administer antibiotics, and particularly powerful broad-spectrum antibiotics, more liberally than infectious disease (ID) experts. I am unaware of any data to support this contention. Nonetheless, if this is true, and it is reasonable for each of us who practices critical care medicine to contemplate, we may be contributing to the problem of multidrug resistance, a modern plague in the ICU. It is also worthwhile for us to think about why it may be so (if it is).

Sepsis may be defined as the systemic effects of an infectious organism and/or its toxins on a host. So the major determinants of the development of sepsis are factors related to the organism (*eg*, virulence and inoculum size) and to the host (*eg*, immunocompetence, mechanical clearance). Whether a patient develops sepsis, sepsis syndrome and, finally, septic shock, and the rate of that progression depend on the

balance of these factors and when, in the temporal progression of sepsis, antibiotics are administered to tip the balance in favor of the host. Few young healthy women develop septic shock from cystitis, a relatively common infectious disease. However, most experienced clinicians have seen patients with diabetes, alcoholism, and what starts as a simple urinary tract infection develop fulminant untreatable septic shock unto death. Even worse, most of us have witnessed young healthy people with no coexisting diseases die rapidly of fulminant meningococcal septic shock, despite administration of appropriate antibiotics.

There are two general approaches to selection of antibiotics in infectious diseases. One approach is to carefully obtain the history and physical examination, to gather appropriate specimens for staining and culture, and to await culture results that guide therapies. The second approach posits that in some situations, one cannot wait for culture results; that waiting could allow the infection to become excessively advanced. The second approach is to treat broadly, with antibiotics, for the most likely pathogens (based on the available data), and when cultures and sensitivities return, to narrow the coverage. Obviously, the two approaches are not mutually exclusive. The choice of antibiotics should be based on efficacy, toxicity, and cost in that order of priority. Recent data suggest that it may also be important to consider the effects of chosen antibiotics on development of resistant pathogens.<sup>1</sup> It appears that the schism between ID specialists and intensivists is that the former gravitate toward awaiting culture/sensitivity results and the latter toward empiric therapy. Moreover, and perhaps as importantly, we must consider whether intensivists are more likely to approach isolated fever as an infectious disease.

Our Chief of Infectious Diseases mentioned to me that "everyone knows how to start antibiotics"; when he assesses a case, he also tries to consider reasons *not to start them*. I tend to use broad-spectrum antibiotics earlier and more liberally than he for empiric therapy of fever and a questionable site of infection. Why are we so different? I suspect that we (intensivists and ID specialists) sometimes differ in our approaches because of inherent differences in our patient populations. Infectious disease physicians care for the full spectrum of severity of infectious diseases, and critically ill patients comprise a minority of most practices. Don't get me wrong; that doesn't imply that intensivists know better. But, intensivists care for patients, at the extreme of the spectrum, with very severe perturbations of host cardiopulmonary status, in whom there is less physiologic margin for delay or error. Our patients frequently have comorbid conditions that render them