The Cost Effectiveness of Noninvasive Ventilation (NIV) in Hospital and Pre-Hospital Settings

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Noninvasive ventilation (NIV), when used in the appropriate patient population, has the ability to improve patient mortality, address patient comfort, and reduce costs.[1] There is strong evidence supporting the application of NIV in patients with congestive heart failure, chronic obstructive pulmonary disease (COPD) exacerbation, immunocomprised patients, and COPD patients being weaned from mechanical ventilation. There is also moderately strong evidence to support NIV in patients with asthma, cystic fibrosis, postoperative respiratory failure, and DNI (do not intubate) patients.[2] NIV is for spontaneously breathing patients only. NIV is contraindicated for hemodynamically unstable patients and patients in cardiac/respiratory arrest, with insufficient respiratory drive, or with upper airway obstruction.[3] This paper highlights the cost effectiveness of NIV within both the pre-hospital and hospital settings. While NIV offers significant cost advantages over traditional ventilation via endotracheal intubation, it also offers equally significant benefits to patients in the form of decreased length of stay, reduced sedation that is associated with intubation and decreased morbidity and mortality rates.[4,5,6] Furthermore, many patients in respiratory distress may be spared the misery of endotracheal intubation, which takes away their ability to communicate, and the accompanying sedation, which deprives them of their cognitive abilities. Although the need for invasive ventilation will always exist, many patients can be successfully treated with NIV.

Pre-hospital use of NIV

Until recent years, NIV was reserved for in-hospital settings, but thanks to improvements in equipment and education, the benefits of NIV may begin as early as when first responders arrive in a patient's home. In recent years, pre-hospital CPAP (continuous positive airway pressure) devices, which deliver a basic form of noninvasive ventilatory support, have been adopted in many emergency medical services (EMS) systems worldwide. Until the advent of CPAP, EMS providers were limited to using either 100% high flow oxygen via mask or intubation for patients in acute respiratory distress. CPAP now offers a new alternative to patient care in the pre-hospital setting. In a 2008 article, Houston Fire Department paramedic, Charles Harper, explained that medical personnel caring for patients with COPD exacerbation and pulmonary edema started using CPAP devices for their patients instead of intubating them. According to the article, patients who ended up intubated and in the ICU typically had first-day ventilation costs of approximately $8,000. Officials for Memorial Hermann Hospital in Houston, Texas, acknowledged that initiating CPAP instead of intubating some of these patients could save an estimated $800,000 per year.[7]

A study by Hubble et al that was featured in the July 2008 issue of Prehospital Emergency Care, evaluated the cost-effectiveness of NIV in pre-hospital settings. Their analysis showed a significant cost reduction and improved patient outcomes when using CPAP.

During a one-year period, CPAP was used 120 times (4:1000 patients). The cost per CPAP application was $89 and resulted in .75 lives saved for every 1000 patients treated at a cost of $490 per life saved. The average length of stay (LOS) in the hospital for non-intubated patients was 5 days vs 10 days for intubated patients, of which at least 5 days were in the ICU. Using the total criteria, the hospital savings were estimated at $499,717 per year, less the cost of equipment, supplies and training.[8] In reviewing Dr Hubble's study, Dr Keith Wesley, Minnesota State EMS Director, suggested that these savings were fairly conservative and that a hospital with more frequent intubation rates could save an estimated $1,118,050 per year. This would result in a cost savings of $9,317 per CPAP use.[9]

NIV in the hospital

The economic benefits of using NIV in the hospital setting are well documented for both acute and chronic patients.[4,5] Many studies have shown not only the cost effectiveness of NIV but the beneficial aspects to patient care.[4,5,8,9]

In the United Kingdom a randomized control trial was conducted in 14 participating centers. The researchers found that noninvasive ventilation reduced the need for intubation by 44% and the in-hospital mortality decreased by 50% in patients with severe exacerbation of chronic pulmonary disease.[4] Another review in the United States concluded that NIV was associated with lower rates of pneumonia, intubation, and mortality.[10]

Nava et al explained that NIV is widely used today as a valid treatment to avoid intubation and its complications.[11] While conventional invasive ventilation is a life-saving procedure; the most important risk factor is in fact endotracheal intubation.[11] Nava pointed out that the risks of endotracheal intubation include nosocomial pneumonia, damaged tracheal mucosa, increased patient discomfort, the inability to speak, and the need for sedatives. Therefore, NIV should be considered in early

treatment of established acute respiratory failure (ARF) patients to avoid further deterioration and intubation.[11] Dr Arroliga, head of Critical Care Medicine at the Cleveland Clinic, believes that NIV avoids the complications of intubation, incurs shorter stays in the hospital, lowers mortality rates, and lowers healthcare costs. Another advantage he pointed out is that NIV is more comfortable for patients as they can retain the ability to speak, swallow, and protect their airway.[12]

Ventilator-associated pneumonia

Whenever a patient is intubated, they run the risk of contracting an infection known as ventilator-associated pneumonia (VAP). VAP is one of the most significant risks facing intubated patients on a ventilator.[13,14] According to the Centers for Medicare and Medicaid Services, the average cost of a VAP infection runs about $135,795 per hospital stay with an estimated 30,867 reported cases of VAP in the US each year.[15] In a statement by the Center for Disease Control and Prevention's National Nosocomial Infection Surveillance System (NNIS) in their 2002 report, patients receiving continuous mechanical ventilation were 6 to 21 times more at risk for developing healthcare-associated pneumonia than those patients who were not receiving mechanical ventilation.[16] In reviewing cohort studies by various physicians, their findings suggested that implementing NIV results in a decreased rate of nosocomial pneumonia and infections.[17] Dr Dean Hess compared 12 studies relating to NIV being administered to patients at risk for pneumonia. The study revealed that compared to patients receiving invasive mechanical ventilation (in four studies), the rate of pneumonia was lower with the use of NIV. In addition, Hess suggested that ventilator associated pneumonia is a misnomer, and perhaps "endotracheal-tube-associated-pneumonia" is a more accurate term. With NIV, because there is no intubation, there is virtually no risk of VAP.[10]

NIV for COPD

COPD is one of the leading causes of death, illness and disability in the United States.[14] In 2000, COPD caused 119,000 deaths, 726,000 hospitalizations, and 1.5 million emergency department visits.[17] The standard treatment generally includes inhaled bronchodilators, systemic corticosteroids, supplemental oxygen, and antibiotics.[14] In one particular study, the cost-effectiveness of NIV, added to the standard treatment, was reviewed and analyzed from the data obtained by several studies.[5] The primary outcomes that the authors were looking for was to see a reduction in hospital mortality and endotracheal intubations. Their cost analysis revealed that using NIV instead of endotracheal intubation in patients with acute exacerbation of COPD resulted in cost savings of $3,244 per patient admission.[5] With all the documented clinical trials showing the clinical effectiveness of NIV in this patient group and the cost savings for the hospital, Keenan et al felt that NIV showed a clear dominance in this arena. Viewing this from a hospital perspective, NIV demonstrates a clear economic value in the treatment of severe, acute exacerbation of COPD.[5]

NIV success factors

European countries are also seeing an increase in the use of NIV for the treatment of patients with COPD.[18] An article featured in the European Respiratory Journal cited that a lack of training was the main reason NIV was not implemented more often.[18] According to Leger et al any hospital that has the potential for treating patients with acute and chronic respiratory failure should have noninvasive ventilation available to them. It was also stated that the experience and training of the staff to adequately monitor the patient was clearly linked to the success of NIV.[18] This article revealed that with proper training and education, NIV is a very successful tool for the treatment of patients with COPD.

The successful implementation of NIV also depends on the acceptance and compliance of the patient; which is influenced by the clinicians attitude and level of confidence in initiating NIV may play an important role.[18] This is why education and training are essential for the health care professional.[18] In a study conducted over an 8-year period (1992-1999) in patients with ARF, 248 patients were analyzed.[19] The result showed that NIV success rates increased over the course of time with education and experience of the patient care staff. Carlucci concluded in her study that clinical practice may change over time so that with increased staff training more severely ill patients may be successfully treated with NIV at a lower cost and reduced risk of failure.[19]

Conclusions

With a mounting body of evidence now available for review, NIV is clearly very cost-effective and a more efficient form of treatment for patients who are within the treatment criteria.[1,4,5,8,12,20] Today, NIV represents one of the current medical technologies proven to help reduce length of stay, morbidity, mortality, risks of infection, and cost of care.[1,4,5,8,10,11,20] As NIV eliminates the financial and clinical consequences of unnecessary endotracheal intubations in the pre-hospital setting, it behooves hospital administrators and clinicians, in close association with their EMS partners, to expand the use of NIV. Using NIV as the first form of treatment, especially in patients with acute exacerbation of COPD and acute pulmonary edema, from the pre-hospital setting through the hospital will save on medical costs and improve outcomes to the benefit of patients and healthcare providers alike. While NIV may not be appropriate for all patient types, understanding NIV protocols and guidelines will help clinicians make better decisions for their patients.

Faced with ever increasing cost control pressures, it may be encouraging to know that the clinical and economic advantages of NIV, in appropriate patient populations, represent a significant untapped or under-utilized source of savings that can actually improve patient outcomes.

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