Evidence-Based Medicine: Non-Invasive Positive Pressure Ventilation for Severe Acute Asthma Exacerbations

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Abstract

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Objective

To determine the efficacy of non-invasive positive pressure ventilation (NPPV) in adults with severe asthma, in comparison to usual medical management, with regard to mortality, endotracheal intubation, blood gas changes, and length of hospital stay.

Search Strategy

A search for studies was carried out using CENTRAL, MEDLINE, EMBASE, CINAHL, Science Citation, web-based clinical trials databases, key journals with web sites, and respiratory conference proceedings. In addition, the references of each randomized controlled trial obtained (and any review articles) was searched for additional studies.

Study Selection

Only randomized controlled clinical trials with a primary hospital admission diagnosis of severe acute asthma were included in this review. Studies were also included if the intervention was usual medical care (UMC) plus NPPV for the management of severe acute asthma, compared to UMC alone. Primary outcome measures were endotracheal intubation and

mortality during the hospital admission. Secondary outcome measures included respiratory rate, arterial blood gas and pH, lung function measurements, length of hospital stay, length of ICU stay, treatment failure (the combination of mortality, endotracheal intubation, and intolerance to the allocated treatment), symptom score, and complications.

Data Extraction

Two reviewers independently assessed all selected studies. The trials entered were ranked according to the Cochrane approach for allocation concealment (Schulz, 1995). A standard form was used to collect the following: characteristics of the study; participants; intervention; control; outcomes; and results. This data was subsequently entered into Review Manager 4.2.4 (RevMan) for statistical analysis. For continuous variables, a weighted mean difference (WMD) and 95% confidence interval (95% CI) was calculated for each study outcome. For dichotomous variables, relative risk (RR) with 95% CI was calculated.

Main Results

From an initial search of 696 abstracts, 11 studies were obtained in full-text for further examination. Of these, only one was included for review.

Primary Outcomes

The one included study reported no deaths or endotracheal intubations in either study group.

Secondary Outcomes

Several outcomes were significantly in favor of NPPV treatment of severe acute asthma compared to the control group. These secondary outcomes included lower hospitalization rates (RR: 0.28; 95% CI: 0.09 to 0.84), and a higher number of Emergency Department discharges after treatment with NPPV (RR: 2.26, 95% CI: 1.03 to 4.97). After 3 hours of NPPV administration, a number of outcomes varied greatly between the two groups: percent predicted FEV1 (WMD:13.8%; 95% CI: 2.28 to 25.32), FVC (WMD:14.60%; 95% CI: 2.23 to 26.97), PEFR (WMD:16%; 95%CI: 2.38 to 29.62), and respiratory rate (WMD:-3.20 bpm; 95%CI: -5.74 to –0.66). Treatment failure, length of ICU stay, and heart rate were not significantly different between the two groups.

Adverse Effects

No data was reported for asthma symptoms or treatment complications.

Conclusions

After a comprehensive literature search, only one published randomized controlled trial was identified that examined the effect of NPPV in the management of severe acute asthma [5]. For patients with severe acute asthma, this single trial demonstrated that NPPV is highly effective in improving lung function and respiratory rate, and in decreasing hospitalization. Although this study appears to show a rapid improvement in clinical and laboratory parameters for severe asthmatics using NPPV, the use of NPPV in status asthmaticus is controversial. Further randomized controlled trials are needed to fully ascertain the benefits, and/or risks of using NPPV for severe asthmatics prior to its widespread implementation.

Commentary: Clinical Implication

Severe asthma exacerbations are a cause for significant mortality and cost to developed countries. There are close to 2 deaths per 100,000 in a population, and U.S. studies estimate the direct cost of asthma to be approximately 6 billion dollars [1,2]. Current trends seem to show that Emergency Department visits for asthma exacerbation is increasing whereas the hospitalizations and death rates have seemed to level off or decline [1]. Adolescents and young adults are the most likely age groups to visit the ED for treatment with females and blacks having higher rates of hospital admission [2,3].

Asthma is a reversible obstructive pulmonary disease characterized by airway inflammation and bronchospasm. Different triggers provoke attacks for different individuals. Exposure to allergens both indoor and outdoor, air pollutants, respiratory tract infections, exercise, weather changes, foods, drugs, GERD and emotion are all triggers for a variety of persons [2]. During an acute exacerbation, the inspiratory muscles bear the brunt of the work of breathing, and when ventilatory demand exceeds the ability of

the respiratory muscles to work, respiratory failure ensues [4]. Hypercapnia is a result of the inability of the body to properly ventilate and, in theory, NPPV works by improving gas exchange, effecting bronchodilation and reducing the increased work of breathing associated with initiation of inspiratory flow [2,5].

NPPV has been shown to be effective in the treatment of COPD exacerbations and has long been thought to be effective for asthma as well, since the mechanisms by which asthma and COPD affect lung function are quite similar [5]. Typically, when a patient fails medical management in asthma, she is managed with endotracheal intubation. Intubation is associated with many risks, such as respiratory depression, cardiac arrhythmias, and local tissue damage. The patient must then be attached to a ventilator and transferred to the ICU which, has the potential to cause ventilator-associated pneumonia, pneumothorax and sinusitis. There are also considerable difficulties in weaning these patients from the ventilator and prolonged stays in the ICU are not uncommon [6].

This review examined 11 trials to review the efficacy of NPPV in adults with severe asthma, in comparison to usual medical care, with respect to mortality, tracheal intubation, changes in blood gases and hospital length of stay. Out of those 11 trials, 10 were excluded and one included.

The included trial was by Soroksky et. al (2003), which randomized 15 ED patients to the experimental group (NPPV and UMC), and 15 to the control group (sham NPPV and UMC). NPPV included a nasal BiPAP model mask with maximum inspiratory and expiratory pressures of 15 cm and 5 cm H2O, respectively. The study showed that severe asthma attack patients who received NPPV had their attacks alleviated faster, had approximately 2/3 fewer hospitalizations, had an over two-fold increased chance of being discharged from the ED, and had improved lung function test results (FEV1, FVC, PEFR). The included study reported no deaths or endotracheal intubations (both primary outcomes of the current review article) in either study group.

The Meduri 96 (retrospective review) study that was excluded from this review included 17 patients with asthma with an average pH of 7.25 and PaCo2 of 65. Only 2 of these 17 patients needed to be intubated, and the authors conclude that NPPV appears to be highly effective in correcting gas exchange and avoiding intubation in severe asthma.

Since only one study met the Cochrane requirements, it is difficult to impossible for there to be a consensus regarding NPPV use in all severe acute asthma exacerbations. Along with publication bias, there are several other potential limitations to the review, including selection bias and standardization of the usual medical care that patients received in the study by Soroksky et. al (2003).

Although there are many obstacles in concluding that NPPV is useful in the treatment of severe acute asthma, it does seem to show promising possibilities. Even though routine clinical use is not recommended, the relative safety of NPPV should make it a useful adjunct preceding endotracheal intubation in the conscious patient that is able to tolerate the machine and mask. As always, preparation for emergent intubation should be ready at the bedside in case the need for it arises.

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