Effect of Out-of-Hospital Noninvasive Positive-Pressure Support Ventilation in Adult Patients With Severe Respiratory Distress: A Systematic Review and Meta-analysis

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Study objective: Noninvasive positive-pressure ventilation (NIPPV) is increasingly being used by emergency medical services (EMS) for treatment of patients in respiratory distress. The primary objective of this systematic review is to determine whether out-of-hospital NIPPV for treatment of adults with severe respiratory distress reduces inhospital mortality compared with "standard" therapy. Secondary objectives are to examine the need for invasive ventilation, hospital and ICU length of stay, and complications.

Methods: Electronic searches of MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials, and Cumulative Index to Nursing and Allied Health Literature were conducted and reference lists of relevant articles hand searched. Randomized controlled trials comparing out-of-hospital NIPPV with standard therapy in adults (aged ≥16 years) with severe respiratory distress published in English were included. Two reviewers independently screened abstracts, assessed quality of the studies, and extracted data. Data were pooled with random-effects models and reported as risk ratios (RRs) with 95% confidence intervals (CIs) and number needed to treat (NNT).

Results: Seven randomized controlled trials were included, with a combined total of 632 patients; 313 in the standard therapy group and 319 in the NIPPV group. In patients treated with NIPPV, the pooled estimate showed a reduction in both inhospital mortality (RR 0.58; 95% CI 0.35 to 0.95; NNT=18) and need for invasive ventilation (RR 0.37; 95% CI 0.24 to 0.58; NNT=8). There was no difference in ICU or hospital length of stay.

Conclusion: Out-of-hospital administration of NIPPV appears to be an effective therapy for adult patients with severe respiratory distress. [Ann Emerg Med. 2014;63:600-607.]

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INTRODUCTION

Severe dyspnea is a common presenting complaint to emergency medical services (EMS) providers. Dyspnea can result from a variety of conditions, including acute cardiogenic pulmonary edema, acute exacerbation of chronic obstructive pulmonary disease, acute asthma exacerbation, and pneumonia. Out-of-hospital treatment of patients in severe respiratory distress presents unique challenges. These patients often require positive-pressure ventilation, but may have factors that make invasive ventilation by intubation or insertion of a supraglottic airway device difficult. Examples of such factors include intact airway reflexes, environmental challenges, and intubation's being a low-frequency skill for most paramedics.[1-3] Additionally, "standard" out-of-hospital therapy for severe dyspnea is diverse, depending on the region of the world, ranging from simple supplemental oxygen therapy to diuretic and ionotropic infusions. The approaches currently used are varied and lack evidence to support any particular practice patterns.

Inhospital treatment of acute cardiogenic pulmonary edema and acute exacerbation of chronic obstructive pulmonary disease with noninvasive positive-pressure ventilation (NIPPV), which includes continuous and bilevel pressure modalities, has been studied extensively.[4-9] A recent Cochrane review of 21 studies involving 1,071 adult patients with acute cardiogenic pulmonary edema reported significantly reduced inhospital mortality (risk ratio [RR] 0.6; 95% confidence interval [CI] 0.45 to 0.84) and intubation (RR 0.53; 95% CI 0.34 to 0.83) when NIPPV was compared with standard medical care.[4] A second Cochrane review of 14 studies involving 758 patients with acute exacerbation of chronic obstructive pulmonary

Editor's Capsule Summary

What is already known on this topic

Out-of-hospital providers have few options for treating severe respiratory distress.

What question this study addressed

Does out-of-hospital noninvasive positive-pressure ventilation (NIPPV) reduce mortality?

What this study adds to our knowledge

In this meta-analysis of 7 randomized controlled trials including 632 adults, NIPPV was associated with reduced mortality and a reduced need for intubation.

How this is relevant to clinical practice

This meta-analysis supports the expanded use of out-of-hospital NIPPV for severe respiratory distress in adults.

disease on the use of NIPPV showed similarly impressive results, with reductions in hospital mortality (RR 0.52; 95% CI 0.35 to 0.76) and need for intubation (RR 0.41; 95% CI 0.33 to 0.53).[7]

A number of commercial systems are available that allow NIPPV to be administered out-of-hospital relatively easily without large ventilators.[10-13] NIPPV is increasingly being used by EMS providers for the treatment of severe respiratory distress in the out-of-hospital setting.[14-23] The primary objective of our systematic review was to determine whether out-of-hospital–administered NIPPV for the treatment of adults (aged ≥16 years) with severe respiratory distress reduces inhospital mortality compared with standard therapy. Our secondary objectives included hospital length of stay, ICU length of stay, need for invasive ventilation, and complications arising from the use of NIPPV.

MATERIALS AND METHODS

The systematic literature searches were conducted in MEDLINE (1946 to December 2012), EMBASE Classic and EMBASE (1947 to week 48, 2012), Cumulative Index to Nursing and Allied Health Literature (1982 to December 2012), and Cochrane Central Register of Controlled Trials (December 2012) by a research librarian with formal training in electronic literature searching.

Only randomized controlled trials comparing the use of out-of-hospital NIPPV with standard therapy in adults (aged ≥16 years) in severe respiratory distress with a suspected diagnosis of acute cardiogenic pulmonary edema, acute exacerbation of chronic obstructive pulmonary disease, acute asthma exacerbation, or pneumonia were included in this review.

A sensitive search strategy (Appendix E1, available online at http://www.annemergmed.com) included a combination of subject headings and free text words using various spelling and endings, such as but not limited to the following terms: "out-of-hospital," "pre-hospital," "emergency medical services," "paramedic," "emergency care," "continuous positive airway pressure," "CPAP," "nCPAP," "bilevel positive airway pressure," "BIPAP," "non-invasive ventilation," "NIV," "non-invasive positive pressure ventilation," "NIPPV," "NPPV," "positive pressure ventilation," "non-invasive mechanical ventilation," "pulmonary edema," "oedema," "chronic obstructive pulmonary disease," "COPD," "heart failure," "asthma," "respiratory insufficiency," and "respiratory distress."

Because NIPPV is a general term for a variety of noninvasive modalities with various terminologies, studies that reported the use of continuous positive airway pressure (CPAP), noninvasive CPAP, bilevel positive airway pressure (BiPAP), biphasic positive airway pressure, biphasic CPAP, bilevel noninvasive pressure support ventilation, and noninvasive pressure support ventilation were included.

The searches were restricted to studies published in the English language. An optimized hedges filter and keywords were used to refine search results to randomized controlled trials and systematic reviews published on the topic. The search strategies were modified for each database with prespecified terms, search filters, and fields. Reference lists of retrieved studies were hand searched for relevant citations, and the regulatory Web site clinicaltrials.gov was also searched to identify ongoing or unpublished trials. Two authors independently screened the search output to identify potentially eligible trials, the full texts of which were retrieved and assessed for inclusion (Figure 1). Individual study authors were contacted to retrieve additional information and clarification when needed.

Outcome Measures

Our primary outcome of interest was inhospital mortality. Our secondary outcomes included ICU length of stay, hospital length of stay, need for invasive ventilation, and complications arising from the use of NIPPV.

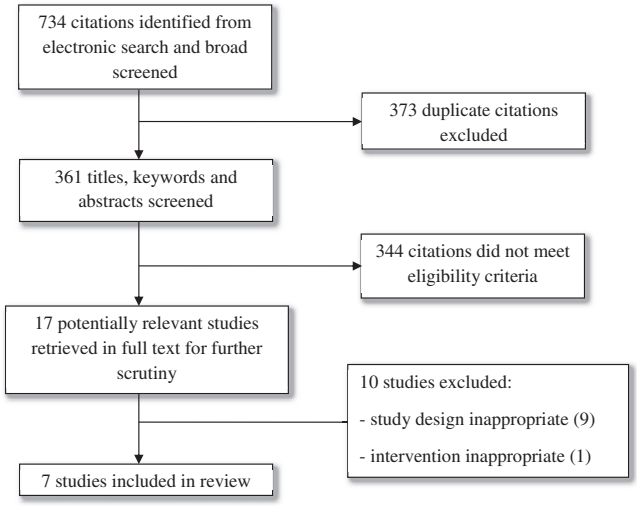

Figure 1. Flow diagram of included studies.