Non-invasive positive pressure ventilation for treatment of respiratory failure due to severe acute exacerbations of asthma (Review)

Rowe BH, Wedzicha JA

This is a reprint of a Cochrane review, prepared and maintained by The Cochrane Collaboration and published in The Cochrane Library 2009, Issue 1

http://www.thecochranelibrary.com

WILEY Publishers Since 1807

Copyright © 2009 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.
TABLE OF CONTENTS

HEADER ................................................................. 1
ABSTRACT ............................................................... 1
PLAIN LANGUAGE SUMMARY .......................................... 2
BACKGROUND ........................................................... 3
OBJECTIVES ............................................................ 3
METHODS ............................................................... 3
RESULTS ................................................................. 4
DISCUSSION ............................................................... 7
AUTHORS' CONCLUSIONS ................................................ 8
ACKNOWLEDGEMENTS .................................................. 8
REFERENCES ............................................................ 8
CHARACTERISTICS OF STUDIES ..................................... 9
DATA AND ANALYSES .................................................. 13
Analysis 1.1. Comparison 1 NPPV +Usual Medical Care vs Usual Medical Care, Outcome 1 Mortality during hospital admission ................................................................. 13
Analysis 1.2. Comparison 1 NPPV +Usual Medical Care vs Usual Medical Care, Outcome 2 Endotracheal intubation ................................................................. 14
Analysis 1.3. Comparison 1 NPPV +Usual Medical Care vs Usual Medical Care, Outcome 3 Hospitalisation rates ................................................................. 14
Analysis 1.4. Comparison 1 NPPV +Usual Medical Care vs Usual Medical Care, Outcome 4 Discharge home from emergency department after treatment ................................................................. 15
Analysis 1.5. Comparison 1 NPPV +Usual Medical Care vs Usual Medical Care, Outcome 5 Treatment failure ................................................................. 15
Analysis 1.6. Comparison 1 NPPV +Usual Medical Care vs Usual Medical Care, Outcome 6 Length of hospital stay (days) ................................................................. 16
Analysis 1.7. Comparison 1 NPPV +Usual Medical Care vs Usual Medical Care, Outcome 7 Length of ICU stay (hours) ................................................................. 16
Analysis 1.8. Comparison 1 NPPV +Usual Medical Care vs Usual Medical Care, Outcome 8 FEV1 % predicted 3 hours post intervention ................................................................. 17
Analysis 1.9. Comparison 1 NPPV +Usual Medical Care vs Usual Medical Care, Outcome 9 FVC % predicted 3 hours post intervention ................................................................. 17
Analysis 1.10. Comparison 1 NPPV +Usual Medical Care vs Usual Medical Care, Outcome 10 PEFR % predicted 3 hours post intervention ................................................................. 18
Analysis 1.11. Comparison 1 NPPV +Usual Medical Care vs Usual Medical Care, Outcome 11 Heart rate (bpm) - 3 hours post intervention ................................................................. 18
Analysis 1.12. Comparison 1 NPPV +Usual Medical Care vs Usual Medical Care, Outcome 12 Respiratory rate (bpm) - 3 hours post intervention ................................................................. 19
WHAT'S NEW .............................................................. 19
HISTORY ................................................................. 19
CONTRIBUTIONS OF AUTHORS ...................................... 19
DECLARATIONS OF INTEREST ......................................... 19
INDEX TERMS ............................................................. 20
Non-invasive positive pressure ventilation for treatment of respiratory failure due to severe acute exacerbations of asthma

Brian H Rowe², J A Wedzicha¹

¹Royal Free & University College Medical School, London, UK. ²Department of Emergency Medicine, University of Alberta, Edmonton, Canada

Contact address: J A Wedzicha, Royal Free & University College Medical School, Hampstead Campus, London, NW3 2PF, UK. j.a.wedzicha@medsch.ucl.ac.uk. (Editorial group: Cochrane Airways Group.)

Cochrane Database of Systematic Reviews, Issue 1, 2009 (Status in this issue: Unchanged)
Copyright © 2009 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.
DOI: 10.1002/14651858.CD004360.pub3
This version first published online: 20 July 2005 in Issue 3, 2005.
Last assessed as up-to-date: 9 May 2005. (Help document - Dates and Statuses explained)

This record should be cited as: Rowe BH, Wedzicha JA. Non-invasive positive pressure ventilation for treatment of respiratory failure due to severe acute exacerbations of asthma. Cochrane Database of Systematic Reviews 2005, Issue 3. Art. No.: CD004360. DOI: 10.1002/14651858.CD004360.pub3.

ABSTRACT

Background

Non-invasive positive pressure ventilation (NPPV) has been shown to be effective in chronic obstructive pulmonary disease patients with acute respiratory failure. However, its role in patients with severe acute asthma is uncertain. The pathophysiologic condition of acute respiratory failure in asthma is in many ways similar to that of acute respiratory failure in COPD. Therefore, there is reason to believe that NPPV could also be successful in patients with severe acute asthma.

Objectives

To determine the efficacy of NPPV in adults with severe acute asthma in comparison to usual medical care with respect to mortality, tracheal intubation, changes in blood gases and hospital length of stay.

Search strategy

An initial search for studies was carried out using CENTRAL. Additional searches were also carried out on MEDLINE, EMBASE, CINAHL, Science Citation, web based clinical trials databases and key journals with web sites were also searched as well as respiratory conference proceedings. Following this, the bibliographies of each randomised controlled trial obtained (and any review articles) was searched for additional studies (May 2005).

Selection criteria

Only RCTs in adults patients with severe acute asthma were considered for inclusion. Studies including patients with features of COPD were excluded unless data was provided separately for patients with asthma in studies recruiting both COPD and asthma patients.

Data collection and analysis

All data was analysed using RevMan. For continuous variables, a weighted mean difference and 95% confidence interval (95%CI) was calculated for each study outcome. For dichotomous variables relative risk with 95% confidence interval was calculated.

Main results
From an initial search of 696 abstracts, 11 trials were obtained in full-text for closer examination. Ten trials were excluded and one included. The one included trial, on 30 patients, showed benefit with NPPV when compared to usual medical care alone with significant improvements in hospitalisation rate, number of patients discharged from emergency department, percent predicted FEV$_1$, FVC, PEFR and respiratory rate.

**Authors’ conclusions**

The application of NPPV in patients suffering from status asthmaticus, despite some interesting and very promising preliminary results, still remains controversial. Large, prospective, randomised controlled trials are therefore needed to determine the role of NPPV in status asthmaticus.

**PLAIN LANGUAGE SUMMARY**

**Non-invasive positive pressure ventilation for treatment of respiratory failure due to severe acute exacerbations of asthma**

Non-invasive positive pressure ventilation (NPPV) enhances breathing in acute respiratory conditions by resting fatigued breathing muscles. It has the advantage that it can be applied intermittently for short periods, which may be sufficient to reverse the breathing problems experienced by patients during severe acute asthma. This review was undertaken to determine the effectiveness of NPPV in patients with severe acute asthma. Only one trial could be included in the review; however, compared to usual medical care alone NPPV reduced hospitalisations, increased the number of patients discharged from the emergency department, and improved respiratory rate and lung function measurements. The application of NPPV in patients suffering from status asthmaticus, despite some promising preliminary results, still remains controversial. Further studies are needed to determine the role of NPPV in the management of severe acute asthma.
BACKGROUND

Non-invasive positive pressure ventilation (NPPV) is an alternative treatment option for patients admitted to hospital with hypercapnic respiratory failure secondary to acute exacerbation of chronic obstructive pulmonary disease (COPD) (Booth 1993; Foglio 1992; Kramer 1995; Meduri 1989). Traditionally, patients who do not respond to conventional treatment are invasively mechanically ventilated; this involves sedation, intubation, attachment to a ventilator and transfer to the intensive care unit (ICU). Most patients do recover with tracheal intubation and assisted ventilation; however, these treatments are associated with high morbidity and there may be considerable difficulties weaning this patient group from ventilation (Brochard 1994; Esteban 1995). In addition, although intubation and mechanical ventilation is common practice, complications can result from the intubation process (damage to local tissue, drug interactions, side-effects to procedures) and during the course of ventilation (ventilator associated pneumonia, pneumothorax and sinusitis) (Fagon 1993). Prolonged stays in ICU are therefore not uncommon.

NPPV employs a full facial or nasal mask that administers ventilatory support from a flow generator. NPPV enhances ventilation by unloading fatigued ventilatory muscles and its use has been established in the treatment of patients with a variety of chronic hypoventilatory syndromes (Moloney 1999). NPPV has the advantage that it can be applied intermittently for short periods, which may be sufficient to reverse the ventilatory failure. Moreover, sedation is not required allowing the patient to eat, drink and talk, and also permitting participation in decisions about their own care. Finally, the incidence of nosocomial pneumonia with NPPV use is lower than in intubated patients (Nourdine 1999; Guerin 1997; Kramer 1999). Over the last decade NPPV has been increasingly used as an adjunct therapy in the management of acute exacerbations of COPD, congestive heart failure and other conditions. NPPV has been successfully used to treat patients with COPD who are prone to exacerbations of respiratory failure. A recent systematic review of trials in patients with COPD has shown significant reductions in mortality, need for intubation, complications, treatment failure, length of hospital stay with rapid improvements in blood gases and respiratory rate (Ram 2003).

Although, NPPV has been shown to be effective in COPD patients with acute respiratory failure, its role in patients with acute respiratory failure following an exacerbation of asthma is uncertain. In some ways the pathophysiologic condition of acute asthma is in many ways similar to that of acute respiratory failure in COPD. Therefore, there is reason to believe that NPPV could also be successful in patients with asthma not improving under conventional therapy and who require mechanical ventilation. Unfortunately, only a few reports have described the use of NPPV in patients with respiratory failure due to exacerbations of asthma (Meduri 1991; Benhamou 1992; Thys 1999; Soma 2002) with conflicting results.

OBJECTIVES

The objective of this review was to determine the efficacy of NPPV in adults with severe acute asthma in comparison to usual medical care, with respect to mortality, tracheal intubation, changes in blood gases, and hospital length of stay.

METHODS

Criteria for considering studies for this review

Types of studies

Studies were only included if they were randomised controlled clinical trials (RCT).

Types of participants

Only studies of adult patients with severe acute asthma as the primary reason for admission to hospital was included in this review. All patients had a diagnosis of asthma as defined by internationally accepted criteria (e.g. British Thoracic Society, American Thoracic Society). Studies including patients with features of COPD were excluded unless data were provided separately for patients with asthma in studies recruiting both COPD and asthma patients.

Types of interventions

Studies were included if the intervention was usual medical care (UMC) for the management of severe acute asthma plus NPPV applied through a nasal or facemask compared to UMC alone. Studies providing additional standard therapy such as supplemental oxygen, antibiotics, bronchodilators or steroids were not excluded.

Treatment in the control group could include any form of standard therapy for the management of severe acute asthma; however, it could not involve NPPV.

The following types of trials were not considered for inclusion: patients with a primary diagnosis of pneumonia, weaning studies, patients with other underlying pathologies and studies where continuous positive airway pressure (CPAP) or in which endotracheal intubation preceded enrolment of patients into the trial.

Types of outcome measures

Primary outcomes

- Endotracheal intubation
- Mortality during the hospital admission

Primary outcomes

- Endotracheal intubation
- Mortality during the hospital admission

Secondary outcomes

- Respiratory rate
- Arterial blood gases and pH
• Lung function measurements
• Length of hospital stay
• Length of ITU/ICU stay
• Treatment failure (the combination of mortality, endotracheal intubation and intolerance to the allocated treatment)
• Symptom score (for example Borg scores, VAS)
• Complications

Search methods for identification of studies

Electronic searches
An initial search was conducted using CENTRAL with the following search terms: Asthma AND acute AND (nasal OR mechanical OR non-invasive or non invasive or positive pressure OR intermittent positive pressure OR airway* pressure OR pressure-controlled OR volume-controlled AND ventilat*) OR positive pressure OR bi-level positive pressure OR ventilation support OR NIPPV OR NPPV OR NIV.

In order to reduced the chance of missing potential studies, separate and additional searches were also carried out on MEDLINE, EMBASE, CINAHL, Science Citation, web based clinical trials databases (for example ClinTrials.gov), 20 key journals with web sites were also searched as well as major respiratory conference proceedings (these included American Thoracic Society 1996-2003, British Thoracic Society 1998-2003, European Respiratory Society 1996-2003).

Searching other resources
Companies that manufacture ventilators were also contacted for potential studies as were researchers working in the area. Following this, the bibliographies of each RCT obtained (and any review articles) was searched for additional RCTs. Authors of identified RCTs were contacted for other published, unpublished or ongoing studies.

Data collection and analysis

Selection of studies
Two authors assessed abstracts/titles retrieved through searching independently. There was complete agreement (after discussion) between two reviewers working independently regarding inclusion and exclusion of full-text studies that were obtained for closer examination.

Data extraction and management
Data were extracted independently by two review authors. Unpublished data were requested from the primary authors where necessary. A standard form was used that collected the following data: characteristics of the study (design, methods of randomisation, withdrawals / dropouts); participants (age, gender); intervention (type of NPPV, timing and duration of therapy, co-interventions); control (agent and dose); outcomes (types of outcome measures, timing of outcomes, adverse events); and results. This data were then entered into Review Manager 4.2.4 (RevMan) for statistical analysis.

Assessment of risk of bias in included studies
The methodological quality of the included trials were assessed independently by two reviewers with particular emphasis on allocation concealment (Schulz 1995), which was ranked using the Cochrane approach:
Grade A: Adequate concealment
Grade B: Uncertain
Grade C: Clearly inadequate concealment
Grade D: Not used

Assessment of heterogeneity
Had there been more than one included study, heterogeneity among pooled study estimates was to be tested using the DerSimonian and Laird method; p < 0.05 was considered statistically significant. Results would have been reported using the fixed effect model. If there was sufficient number of studies for a particular outcome that had significant heterogeneity, this would have been investigated based on study quality, duration of NPPV, time to initiation of NPPV, type of NPPV and type of mask used to administer NPPV.

Data synthesis
Data from all trials were analysed using RevMan. 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.

Subgroup analysis and investigation of heterogeneity
Had there been more than one included study, subgroups analyses were to be based on baseline or admission PaCO₂ (< 45mmHg or ≥ 45mmHg or 6 kPa), pH (< 7.30 or ≥ 7.35 to 7.30) and the location of the study within the hospital (ICU or respiratory ward).

Results

Description of studies
See: Characteristics of included studies; Characteristics of excluded studies.

Results of the search
From an initial search of 696 abstracts 11 studies were obtained in full-text for further examination. Of these, ten were excluded (Akingbola 2002; Archis 2001; Clark 1997; Compagnoni 2000; Ergun2002; Fernandez 2001; Meduri 1996; Pollack 1995; Soma 2002; Thys 1999) for reasons provided in the "Characteristics of excluded studies" table. One study (Soroksky 2003) which met
the inclusion criteria was included in the review for which the
details are provided in the "Characteristics of included studies"
table. Updated search for studies (May 2005): One further study
listed in the excluded studies list (Thill 2004).

**Included studies**

The one included study (Soroksky 2003) was conducted in Is-
rael in an emergency department. Fifteen patients each were ran-
domised to the NPPV and control or UMC group. To be eligible
for study enrolment patients had to fulfil all four of the following
severity criteria: FEV$_1$ < 60% of predicted; respiratory rate > 30
breaths/min; history of asthma of at least one year and duration
of current asthma attack of > 7 days. Demographic and baseline
physiologic parameters were similar between the two study groups
(see additional Table 1).

**Table 1.** Soroksky 2003: Demographics and baseline physiological parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>NPPV group (SD)</th>
<th>UMC group (SD)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient number</td>
<td>15</td>
<td>15</td>
<td>-</td>
</tr>
<tr>
<td>Age, years</td>
<td>34.07 (8.55)</td>
<td>32.53 (9.68)</td>
<td>NS</td>
</tr>
<tr>
<td>Female/male gender, number</td>
<td>8/7</td>
<td>7/8</td>
<td>-</td>
</tr>
<tr>
<td>Mean FEV1, % predicted</td>
<td>37.27 (10.69)</td>
<td>33.8 (10.18)</td>
<td>NS</td>
</tr>
<tr>
<td>Mean FEV1, L</td>
<td>1.26 (0.39)</td>
<td>1.16 (0.35)</td>
<td>NS</td>
</tr>
<tr>
<td>Mean FVC, % predicted</td>
<td>48.27 (11.87)</td>
<td>48.6 (16.05)</td>
<td>NS</td>
</tr>
<tr>
<td>Mean FVC, L</td>
<td>1.94 (0.56)</td>
<td>1.94 (0.65)</td>
<td>NS</td>
</tr>
<tr>
<td>Mean PEFR, % predicted</td>
<td>38 (11.95)</td>
<td>34 (11.2)</td>
<td>NS</td>
</tr>
<tr>
<td>Duration of attack, days</td>
<td>2.6 (2.13)</td>
<td>2.07 (1.71)</td>
<td>NS</td>
</tr>
<tr>
<td>Duration of asthma, year</td>
<td>12.13 (9.81)</td>
<td>10.27 (6.33)</td>
<td>NS</td>
</tr>
<tr>
<td>pH</td>
<td>7.41 (0.04)</td>
<td>7.40 (0.02)</td>
<td>NS</td>
</tr>
<tr>
<td>PaCO2, mm Hg</td>
<td>33.59 (3.48)</td>
<td>34.29 (5.41)</td>
<td>NS</td>
</tr>
<tr>
<td>PaO2, mm Hg</td>
<td>82.85 (38.72)</td>
<td>85.82 (29.6)</td>
<td>NS</td>
</tr>
<tr>
<td>Hemoglobin, g/dL</td>
<td>14.08 (2.47)</td>
<td>14.41 (2.87)</td>
<td>NS</td>
</tr>
</tbody>
</table>
Table 1. Soroksky 2003: Demographics and baseline physiological parameters  (Continued)

<table>
<thead>
<tr>
<th></th>
<th>UMC 1</th>
<th>UMC 2</th>
<th>NS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate, beats/min</td>
<td>120.8 (19.21)</td>
<td>109.33 (12.02)</td>
<td>NS</td>
</tr>
<tr>
<td>Mean BP, mm Hg</td>
<td>97.32 (6.87)</td>
<td>99.3 (8.67)</td>
<td>NS</td>
</tr>
<tr>
<td>Respiratory rate, breaths/min</td>
<td>34.8 (1.82)</td>
<td>33.53 (1.73)</td>
<td>NS</td>
</tr>
<tr>
<td>Permanent use of inhaled corticosteroids</td>
<td>8</td>
<td>6</td>
<td>NS</td>
</tr>
<tr>
<td>Permanent use of inhaled beta-agonist</td>
<td>14</td>
<td>13</td>
<td>NS</td>
</tr>
<tr>
<td>Permanent use of systemic corticosteroids</td>
<td>2</td>
<td>1</td>
<td>NS</td>
</tr>
<tr>
<td>Prior episodes of acute respiratory failure</td>
<td>2</td>
<td>0</td>
<td>NS</td>
</tr>
</tbody>
</table>

*NPPV group details*

Patients who were eligible were randomly assigned to receive either UMC combined with ventilatory support with NPPV or UMC plus sham NPPV (control group). NPPV was applied through a nasal mask secured with head straps (BiPAP model ST; Respirationics; Murrysville, PA). NPPV was applied for three hours in both groups and any interruption of the NPPV application was allowed only for the following reasons: performance of spirometry, nebulisation of aerosolised bronchodilators via a small-volume nebuliser, or clearance of secretions. Each interruption of NPPV application was allowed for not more than five minutes each time. Inspiratory pressure was set at 8 cm H$_2$O and was increased gradually by 2 cm H$_2$O every 15 min to a maximum of 15 cm H$_2$O, or until a respiratory rate of < 25 breaths/min was reached, whichever came first. Expiratory pressure was set at 3 cm H$_2$O and was increased gradually by 1 cm H$_2$O every 15 min to a maximum of 5 cm H$_2$O. The gradual increase in both the inspiratory and expiratory pressures was aimed at increasing patient comfort and patient compliance. These values were set in an arbitrary manner, and were designed to provide what would be considered by most as a mild PEEP (external) and mild-to-moderate inspiratory pressure support. Breathing through the mouth was discouraged, and patients in this group were instructed to breathe only through the nasal mask.

*Control group details*

In order to minimise the possibility of bias from the attending physicians and from the patients themselves, subtherapeutic NPPV (sham) was applied through a nasal mask for 3 h. Both the inspiratory and expiratory pressures were set at 1 cm of H$_2$O. In addition, four large holes (3 mm in diameter) were made in the tube connecting the apparatus and the nasal mask. This was done in order to minimise the therapeutic effect that such low pressures could have and in order to allow unlimited flow of air to the patient. As another means of precaution, patients in this group were not instructed to breath solely through their nasal mask, and oral breathing was allowed. This was done in order to offset any flow limitation or other side effects that a subtherapeutic nasal mask could cause.

Conventional medical management (or UMC) in the two groups was similar and consisted of salbutamol 2.5 mg, ipratropium 0.25 mg, nebulised on average once an hour, and IV corticosteroids (either methylprednisolone or hydrocortisone) at the discretion of the attending physician. Oxygen was administered as needed with the goal of keeping oxygen saturation above 95%. All patients underwent blood gas analysis (blood samples were drawn while patients were breathing room air), CBC count, determination of serum electrolytes, and chest radiograph at the outset.

*Outcome measures*

Spirometry, oxygen saturation, blood pressure, heart rate, and respiratory rate were recorded at time zero, 15 min, 30 min, 60 min, 2 h and 3 h after start of the trial.

*Risk of bias in included studies*

The one included trial reported good methodological quality. Patients were randomised to treatment groups and neither the patient nor the clinician were aware of the study group any patient was assigned. Due to the nature of the intervention, blinding was not possible throughout the study as both the patient and clinician had to be aware of the application of NPPV. However, the authors did make every possible effort to maintain blinding for...
Effects of interventions

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

Secondary outcomes
Multiple secondary outcomes were reported in the included trial. The following outcomes were significantly in favour of NPPV treatment of severe acute asthma compared to sham or control group: hospitalisation rate was lower with NPPV (RR: 0.28; 95%CI: 0.09 to 0.84) and number of patients discharged from emergency department after treatment was higher in the NPPV group (RR: 2.26; 95%CI: 1.03 to 4.97). Outcomes measured at the end of the intervention (3 hours of NPPV application) which significantly differed between the two groups included: percent predicted FEV\(_1\) (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.

There were no data reported on asthma symptoms or treatment complications.

DISCUSSION

NPPV has been used for the treatment of a variety of respiratory and cardiovascular conditions, including acute respiratory failure (ARF) due to status asthmaticus. Despite the benefits of NPPV in COPD and other conditions (ie, improved patient comfort, reduced need for sedation, and avoidance of complications associated with mechanical ventilation), it has not been widely used in severe acute asthma. Following a comprehensive literature search, only one published randomised controlled trial was identified that examined the effect of NPPV in the management of severe acute asthma (Soroksky 2003).

In patients with severe acute asthma, this single trial (Soroksky 2003) demonstrated that NPPV appears highly effective in rapidly improving lung function, respiratory rate and decreasing hospitalisation using low inspiratory pressures (<15 cm H\(_2\)O). Although there are some similarities between asthma and COPD, in asthma CO\(_2\) retention occurs late in the exacerbation and by that time the patient is exhausted and will have difficulty tolerating the NPPV mask and equipment. In the Soroksky study (Soroksky 2003), level of PaCO\(_2\) was not an entry criteria and thus the NPPV was probably used for control of dyspnoea rather than for ventilation. In the Soroksky 2003 study it seems that the NPPV was used in some of the patients in A&E and then patients were discharged as it is surprising that patients tolerated NPPV so quickly and so well. In patients with severe acute asthma, respiratory rate is usually high therefore patients are unable to coordinate their breathing with that of the BiPAP machine and find it uncomfortable and it usually takes these patients at least three hours to get used to NPPV. Furthermore, as the minimum IPAP was 8 cm H\(_2\)O and maximum being 15 cm H\(_2\)O and with an EPAP of up to 5 cm H\(_2\)O it seems likely that Soroksky and co-investigator’s actually gave the patients very little ventilatory support but indeed and actually gave them CPAP only. There is also the issue of mucous retention in asthma as NPPV makes patients quite dry and in severe acute asthma sputum retention is a problem and it is important that this is borne in mind when implementing NPPV use in severe acute asthma.

No other randomised controlled trials have been published on the use of NPPV to treat acute asthma; however, other non-trial evidence is available. Most studies were excluded from this review because they did not include patients with asthma. Among five patients with acute asthma included in a study of 158 patients with acute respiratory failure treated with NPPV (average initial PaCO\(_2\) 67 mmHg, only one patient required intubation, and there were no mortalities (Meduri 1996a). In a larger study (Meduri 1996), 17 patients with asthma and an average initial pH of 7.25 and PaCO\(_2\) of 65 mmHg were treated with NPPV. Only two required intubation (for increasing PaCO\(_2\)). The average duration of ventilation was 16 hours, and no complications occurred. The authors concluded that NPPV appears to be highly effective in correcting gas exchange abnormalities and avoiding intubation in patients with severe acute asthma. In status asthmaticus, the use of corticosteroids, short-acting beta-agonists (SABA) combined with ipratropium bromide (IB) and intravenous magnesium sulfate (MgSO\(_4\)) have all been shown to be highly effective. Due to the paucity of controlled trials no conclusions can be drawn regarding the relative effectiveness of NPPV versus usual medical therapy in severe acute asthma.

The one included trial in this review was able to institute NPPV in selected patients with acute asthma without complications. Its addition to usual medical treatment seems to bring about a rapid improvement of various clinical and laboratory parameters in patients. The authors found no deleterious effect of NPPV when implemented for a short period of time in the emergency department setting. However, despite these promising results from this one trial, the use of NPPV in status asthmaticus remains controversial. Clearly further randomised controlled trial evidence is required to fully assess the role of NPPV in status asthmaticus prior to its
There are several potential limitations to this review. Firstly, one is unable to rule out publication bias as only one positive study has been published to date and secondly one is also unable to exclude selection bias. Finally, the only included study did not standardise and/or maximise therapy in patients with severe acute asthma. The benefit may be over-estimated due to the failure to ensure all patients received early systemic corticosteroids, regular and repeated SABA and IB, as well as IV MgSO4 if required.

AUTHORS’ CONCLUSIONS

Implications for practice

This review provides some promising results in favour of the use of NPPV in severe acute asthma; however, the weaknesses described above and the concern with prolonged hospitalisation suggest that the regular use of NPPV in status asthmaticus still remains controversial. Until large randomised controlled trials are completed, this therapy should be restricted and routine clinical use cannot be recommended.

Implications for research

Large randomised controlled trials are needed to determine the role of NPPV in status asthmatics;

- Attention should be paid to maximizing the treatment of the control group with efficacious asthma treatments such as early systemic corticosteroids, frequent short-acting beta-agonists combined with ipratropium bromide, inhaled corticosteroids and intravenous magnesium sulfate;

- Attempts to mask NPPV treatment (as demonstrated by Soroksky 2003) are possible and should be encouraged to reduce the bias associated with outcome ascertainment.

ACKNOWLEDGEMENTS

The authors would like to thank members of the Cochrane Airways group for their continued support.

REFERENCES

References to studies included in this review

Soroksky 2003 (published and unpublished data)

References to studies excluded from this review

Akingbola 2002 (published data only)

Archis 2001 (published data only)

Clark 1997 (published data only)

Compagnoni 2000 (published data only)

Ergun 2002 (published data only)

Fernandez 2001 (published data only)

Meduri 1996 (published data only)

Pollack 1995 (published data only)

Soma 2002 (published data only)

Thill 2004 (published data only)
Non-invasive positive pressure ventilation for treatment of respiratory failure due to severe acute exacerbations of asthma (Review)

Copyright © 2009 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.

Thys 1999 (published data only)

Additional references

Benhamou 1992

Bott 1993

Brochard 1994

Esteban 1995

Fagon 1993

Foglio 1992

Guerin 1997

Holley 2001
Holley MT, Morrissey TK, Seaberg DC, Afessa B, Wears RL. Ethical dilemmas in a randomized trial of asthma treatment: can Bayesian statistical analysis explain the results?. *Acad Emerg Med* 2001;8(12):1128–35. [PMID: 11733289]

Kramer 1999

Kramer 1999

Levy 1998

Meduri 1989

Meduri 1991

Meduri 1996a

Moloney 1999

Nourdinne 1999

Ram 2003

Schulz 1995

Soma 2002

Thys 1999

* Indicates the major publication for the study
### Characteristics of included studies

**Soroksky 2003**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Methods</strong></td>
<td>Randomised double-blind, placebo controlled trial conducted in the emergency department of the Asaf Harofe Medical Center, Zerifin, Israel.</td>
</tr>
<tr>
<td><strong>Participants</strong></td>
<td>Number of patients in each group: NPPV group = 17, Control group = 16&lt;br&gt;To be eligible to enter the study, the patient had to fulfill all four of the following severity criteria: FEV1 &lt; 60% of predicted by age, height, and gender; respiratory rate &gt; 30 breaths/min; history of asthma of at least 1 year; and duration of current asthma attack of &gt; 7 days. Patients with any of the following were excluded: smoking history of &gt; 10 years, a known chronic pulmonary disease other than asthma, an emergency intubation for cardiorespiratory resuscitation, hemodynamic instability defined as heart rate &gt; 150 beats/min, or systolic BP &lt; 90 mm Hg, altered state of consciousness, congestive heart failure, ischaemic heart disease, upper airway obstruction, facial deformity, pregnancy and pulmonary infiltrates consistent with pulmonary edema or pneumonia.</td>
</tr>
<tr>
<td><strong>Interventions</strong></td>
<td>Duration of intervention = 3 h.&lt;br&gt;Patients who were eligible for inclusion in the study were randomly assigned to receive either standard medical treatment combined with ventilatory support with NPPV or conventional treatment plus sham NPPV (control group).&lt;br&gt;In both groups during the 3 h of the trial, interruption of the NPPV application was allowed only for the following reasons: performance of spirometry, nebulisation of aerosolised bronchodilators via a small-volume nebuliser, or clearance of secretions. Interruption of the NPPV application was allowed for not &gt; 5 min each time.&lt;br&gt;Conventional medical management (control) in the two groups was similar and consisted of salbutamol 2.5 mg and ipratropium 0.25 mg, nebulised on average once an hour, and IV corticosteroids (either methylprednisolone or hydrocortisone) at the discretion of the attending physician. In both groups, NPPV was interrupted each time to deliver aerosolised bronchodilators via a separate small-volume nebuliser. Oxygen was administered as needed with the goal of keeping oxygen saturation above 95%. All patients underwent blood gas analysis (blood samples were drawn while patients were breathing room air), CBC count, determination of serum electrolytes, and chest radiograph at the outset.&lt;br&gt;After randomisation, in both groups in addition to conventional medical management, NPPV was applied through a nasal mask secured with head straps. In the control group, a subtherapeutic NPPV (sham NPPV) was applied, while in the NPPV group therapeutic NPPV with predetermined pressures was applied. In both groups, NPPV was applied for not &gt; 3 h.&lt;br&gt;NPPV Group intervention details: NPPV was applied through a nasal mask secured...</td>
</tr>
</tbody>
</table>
with head straps (BiPAP model ST; Respironics; Murrysville, PA). Inspiratory pressure was set at 8 cm H2O and was increased gradually by 2 cm H2O every 15 min to a maximum of 15 cm H2O, or until a respiratory rate of < 25 breaths/min was reached, whichever came first. Expiratory pressure was set at 3 cm H2O and was increased gradually by 1 cm H2O every 15 min to a maximum of 5 cm H2O. The gradual increase in both the inspiratory and expiratory pressures was aimed at increasing patient comfort and patient compliance. These values were set in an arbitrary manner, and were designed to provide what would be considered by most as a mild PEEP (external) and mild-to-moderate inspiratory pressure support. As opposed to the control group, breathing through the mouth was discouraged, and patients in this group were instructed to breath only through the nasal mask.

Control Group details:
Patients in this group were treated conventionally with nebulised salbutamol, 2.5 mg, and ipratropium, 0.25 mg, administered hourly along with IV corticosteroids as determined by the attending physician. Oxygen was given to maintain saturation at 95%. As a control group and in order to minimise the possibility of bias from the attending physicians and from the patients themselves, subtherapeutic NPPV (sham) was applied through a nasal mask for 3 h. Inspiratory and expiratory pressures were set at 1 cm of water. In addition, four large holes (3 mm in diameter) were made in the tube connecting the apparatus and the nasal mask. This was done in order to minimise the therapeutic effect that such low pressures could have and in order to allow unlimited flow of air to the patient. As another means of precaution, patients in this group were not instructed to breath solely through their nasal mask, and oral breathing was allowed. This was done in order to offset any flow limitation or other side effects that a subtherapeutic nasal mask could have.

Spirometry, oxygen saturation, BP, heart rate, and respiratory rate were recorded at time zero, and 15 min, 30 min, 60 min, 2 h and 3 h after start of the trial.

Outcomes
At 3 hours at which point the study interventioned was stopped the following outcomes were recorded for both the NPPV and control group:
FEV1, % predicted
PEFR, % predicted
FVC, % predicted
Heart rate
Respiratory rate
Other outcomes included:
Number of patients hospitalised,
Duration of hospitalisation,
Number of patients discharged (and their % predicted FEV1, FVC & PEFR),
Length of stay in emergency department.

Notes
Author reply received 01/06/2004 regarding allocation concealment, mortality and endotracheal intubation.

Risk of bias

Non-invasive positive pressure ventilation for treatment of respiratory failure due to severe acute exacerbations of asthma (Review)
Soroksky 2003  (Continued)

<table>
<thead>
<tr>
<th>Item</th>
<th>Authors’ judgement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate sequence generation?</td>
<td>Unclear</td>
<td>Described as randomised and confirmed by investigator, but further inform-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>mation was not available</td>
</tr>
<tr>
<td>Allocation concealment?</td>
<td>Unclear</td>
<td>Information not available</td>
</tr>
</tbody>
</table>

Characteristics of excluded studies  [ordered by study ID]

- **Akingbola 2002**  Case series report.
- **Archis 2001**  Study not conducted in patients with asthma.
- **Clark 1997**  Case-control study.
- **Compagnoni 2000**  Study was testing the delivery of beta-agonists and compared NPPV, Inspiratory positive pressure breathing and spontaneous breathing.
- **Ergun 2002**  Patients in stable state of disease and only includes patients with pachypleuritis and kyphoscoliosis.
- **Fernandez 2001**  Retrospective observational study.
- **Meduri 1996**  Retrospective patient record review.
- **Pollack 1995**  NPPV compared to small volume nebuliers for the delivery of beta-2 agonists.
- **Soma 2002**  Before and after study.
- **Thill 2004**  All patients received both NPPV and usual medical care for 2 hours each using crossover design - first arm data was not presented/analysed separately. Study combined patients with asthma and other obstructive lower airways disease - data for patients with asthma not presented/analysed separately.
- **Thys 1999**  Non-randomised trial.
## DATA AND ANALYSES

### Comparison 1. NPPV + Usual Medical Care vs Usual Medical Care

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Mortality during hospital admission</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Fixed, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>2 Endotracheal intubation</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Fixed, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>3 Hospitalisation rates</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Fixed, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>4 Discharge home from emergency</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Fixed, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>5 Treatment failure</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Fixed, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>6 Length of hospital stay (days)</td>
<td>1</td>
<td></td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>7 Length of ICU stay (hours)</td>
<td>1</td>
<td></td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>8 FEV1 % predicted 3 hours post intervention</td>
<td>1</td>
<td></td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>9 FVC % predicted 3 hours post intervention</td>
<td>1</td>
<td></td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>10 PEFR % predicted 3 hours post intervention</td>
<td>1</td>
<td></td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>11 Heart rate (bpm) - 3 hours post intervention</td>
<td>1</td>
<td></td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>12 Respiratory rate (bpm) - 3 hours post intervention</td>
<td>1</td>
<td></td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>Subtotals only</td>
</tr>
</tbody>
</table>

**Analysis 1.1. Comparison 1 NPPV + Usual Medical Care vs Usual Medical Care, Outcome 1 Mortality during hospital admission.**

Review: Non-invasive positive pressure ventilation for treatment of respiratory failure due to severe acute exacerbations of asthma

Comparison: 1 NPPV + Usual Medical Care vs Usual Medical Care

Outcome: 1 Mortality during hospital admission

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>NPPV n/N</th>
<th>UMC n/N</th>
<th>Risk Ratio M-H,Fixed,95% CI</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorokisky 2003</td>
<td>0/17</td>
<td>0/16</td>
<td>*</td>
<td>0.0 %</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>0</td>
<td>0</td>
<td>0.0 %</td>
<td>0.0 [ 0.0, 0.0 ]</td>
</tr>
</tbody>
</table>

Total events: 0 (NPPV), 0 (UMC)

Heterogeneity: not applicable

Test for overall effect: Z = 0.0 (P < 0.00001)
### Analysis 1.2. Comparison 1 NPPV + Usual Medical Care vs Usual Medical Care, Outcome 2 Endotracheal intubation.

Review: Non-invasive positive pressure ventilation for treatment of respiratory failure due to severe acute exacerbations of asthma

Comparison: 1 NPPV + Usual Medical Care vs Usual Medical Care

Outcome: 2 Endotracheal intubation

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>NPPV n/N</th>
<th>UMC n/N</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soroksky 2003</td>
<td>0/17</td>
<td>0/16</td>
<td>*</td>
<td>0.0 %</td>
<td>0.0 [ 0.0, 0.0 ]</td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>0 0</td>
<td></td>
<td>0.0 %</td>
<td>0.0 [ 0.0, 0.0 ]</td>
<td></td>
</tr>
</tbody>
</table>

Total events: 0 (NPPV), 0 (UMC)
Heterogeneity: not applicable
Test for overall effect: Z = 0.0 (P < 0.00001)

### Analysis 1.3. Comparison 1 NPPV + Usual Medical Care vs Usual Medical Care, Outcome 3 Hospitalisation rates.

Review: Non-invasive positive pressure ventilation for treatment of respiratory failure due to severe acute exacerbations of asthma

Comparison: 1 NPPV + Usual Medical Care vs Usual Medical Care

Outcome: 3 Hospitalisation rates

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>NPPV n/N</th>
<th>UMC n/N</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soroksky 2003</td>
<td>3/17</td>
<td>10/16</td>
<td></td>
<td>0.0 %</td>
<td>0.28 [ 0.09, 0.84 ]</td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>0 0</td>
<td></td>
<td>0.0 %</td>
<td>0.0 [ 0.0, 0.0 ]</td>
<td></td>
</tr>
</tbody>
</table>

Total events: 3 (NPPV), 10 (UMC)
Heterogeneity: not applicable
Test for overall effect: Z = 0.0 (P < 0.00001)
### Analysis 1.4. Comparison 1 NPPV +Usual Medical Care vs Usual Medical Care, Outcome 4 Discharge home from emergency department after treatment.

Review: Non-invasive positive pressure ventilation for treatment of respiratory failure due to severe acute exacerbations of asthma

Comparison: 1 NPPV +Usual Medical Care vs Usual Medical Care

Outcome: 4 Discharge home from emergency department after treatment

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>NPPV n/N</th>
<th>UMC n/N</th>
<th>Risk Ratio M-H,Fixed 95% CI</th>
<th>Weight</th>
<th>Risk Ratio M-H,Fixed 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soroksky 2003</td>
<td>12/17</td>
<td>5/16</td>
<td>2.26 [1.03, 4.97]</td>
<td>0.0 %</td>
<td>2.26 [1.03, 4.97]</td>
</tr>
</tbody>
</table>

Subtotal (95% CI) 0 0 0.0 % 0.0 [0.0, 0.0]

Total events: 12 (NPPV), 5 (UMC)

Heterogeneity: not applicable

Test for overall effect: Z = 0.0 (P < 0.00001)

### Analysis 1.5. Comparison 1 NPPV +Usual Medical Care vs Usual Medical Care, Outcome 5 Treatment failure.

Review: Non-invasive positive pressure ventilation for treatment of respiratory failure due to severe acute exacerbations of asthma

Comparison: 1 NPPV +Usual Medical Care vs Usual Medical Care

Outcome: 5 Treatment failure

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>NPPV n/N</th>
<th>UMC n/N</th>
<th>Risk Ratio M-H,Fixed 95% CI</th>
<th>Weight</th>
<th>Risk Ratio M-H,Fixed 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soroksky 2003</td>
<td>2/17</td>
<td>1/16</td>
<td>1.88 [0.19, 18.80]</td>
<td>0.0 %</td>
<td>1.88 [0.19, 18.80]</td>
</tr>
</tbody>
</table>

Subtotal (95% CI) 0 0 0.0 % 0.0 [0.0, 0.0]

Total events: 2 (NPPV), 1 (UMC)

Heterogeneity: not applicable

Test for overall effect: Z = 0.0 (P < 0.00001)
### Analysis 1.6. Comparison 1 NPPV +Usual Medical Care vs Usual Medical Care, Outcome 6 Length of hospital stay (days).

Review: Non-invasive positive pressure ventilation for treatment of respiratory failure due to severe acute exacerbations of asthma

Comparison: 1 NPPV +Usual Medical Care vs Usual Medical Care

Outcome: 6 Length of hospital stay (days)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>NPPV</th>
<th>UMC</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soroksky 2003</td>
<td>3</td>
<td>12</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable

Test for overall effect: Z = 0.0 (P < 0.00001)

### Analysis 1.7. Comparison 1 NPPV +Usual Medical Care vs Usual Medical Care, Outcome 7 Length of ICU stay (hours).

Review: Non-invasive positive pressure ventilation for treatment of respiratory failure due to severe acute exacerbations of asthma

Comparison: 1 NPPV +Usual Medical Care vs Usual Medical Care

Outcome: 7 Length of ICU stay (hours)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>NPPV</th>
<th>UMC</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soroksky 2003</td>
<td>15</td>
<td>15</td>
<td>0.0%</td>
<td>0.30%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable

Test for overall effect: Z = 0.0 (P < 0.00001)
**Analysis 1.8. Comparison 1 NPPV +Usual Medical Care vs Usual Medical Care, Outcome 8 FEV1 % predicted 3 hours post intervention.**

Review: Non-invasive positive pressure ventilation for treatment of respiratory failure due to severe acute exacerbations of asthma

Comparison: 1 NPPV +Usual Medical Care vs Usual Medical Care

Outcome: 8 FEV1 % predicted 3 hours post intervention

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>NPPV</th>
<th>UMC</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>N Mean(SD)</td>
<td>N Mean(SD)</td>
<td>N Mean(SD)</td>
<td>N/Fixed,95% CI</td>
<td>IV/Fixed,95% CI</td>
<td></td>
</tr>
<tr>
<td>Soroksky 2003</td>
<td>15 56.1 (16.3)</td>
<td>15 42.3 (15.9)</td>
<td>-13.80 [ 2.28, 25.32 ]</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>0</td>
<td>0</td>
<td>0.0 %</td>
<td>0.0 [ 0.0, 0.0 ]</td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable

Test for overall effect: Z = 0.0 (P < 0.00001)

**Analysis 1.9. Comparison 1 NPPV +Usual Medical Care vs Usual Medical Care, Outcome 9 FVC % predicted 3 hours post intervention.**

Review: Non-invasive positive pressure ventilation for treatment of respiratory failure due to severe acute exacerbations of asthma

Comparison: 1 NPPV +Usual Medical Care vs Usual Medical Care

Outcome: 9 FVC % predicted 3 hours post intervention

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>NPPV</th>
<th>UMC</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>N Mean(SD)</td>
<td>N Mean(SD)</td>
<td>N Mean(SD)</td>
<td>N/Fixed,95% CI</td>
<td>IV/Fixed,95% CI</td>
<td></td>
</tr>
<tr>
<td>Soroksky 2003</td>
<td>15 70.6 (13.8)</td>
<td>15 56 (20.18)</td>
<td>14.60 [ 2.23, 26.97 ]</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>0</td>
<td>0</td>
<td>0.0 %</td>
<td>0.0 [ 0.0, 0.0 ]</td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable

Test for overall effect: Z = 0.0 (P < 0.00001)
### Analysis 1.10. Comparison 1 NPPV +Usual Medical Care vs Usual Medical Care, Outcome 10 PEFR % predicted 3 hours post intervention.

Review: Non-invasive positive pressure ventilation for treatment of respiratory failure due to severe acute exacerbations of asthma

Comparison: 1 NPPV + Usual Medical Care vs Usual Medical Care

Outcome: 10 PEFR % predicted 3 hours post intervention

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>NPPV</th>
<th>UMC</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorokisky 2003</td>
<td>15</td>
<td>16</td>
<td>0.0 % 16.00 [ 2.38, 29.62 ]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>0</td>
<td>0</td>
<td>0.0 % 0.0 [ 0.0, 0.0 ]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable

Test for overall effect: Z = 0.0 (P < 0.00001)

Non-invasive positive pressure ventilation for treatment of respiratory failure due to severe acute exacerbations of asthma (Review)

Copyright © 2009 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.

---

### Analysis 1.11. Comparison 1 NPPV +Usual Medical Care vs Usual Medical Care, Outcome 11 Heart rate (bpm) - 3 hours post intervention.

Review: Non-invasive positive pressure ventilation for treatment of respiratory failure due to severe acute exacerbations of asthma

Comparison: 1 NPPV + Usual Medical Care vs Usual Medical Care

Outcome: 11 Heart rate (bpm) - 3 hours post intervention

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>NPPV</th>
<th>UMC</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorokisky 2003</td>
<td>15</td>
<td>15</td>
<td>0.0 % 5.60 [ -3.21, 14.41 ]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>0</td>
<td>0</td>
<td>0.0 % 0.0 [ 0.0, 0.0 ]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable

Test for overall effect: Z = 0.0 (P < 0.00001)
**Analysis 1.12. Comparison of NPPV +Usual Medical Care vs Usual Medical Care, Outcome 12 Respiratory rate (bpm) - 3 hours post intervention.**

Review: Non-invasive positive pressure ventilation for treatment of respiratory failure due to severe acute exacerbations of asthma.

Comparison: NPPV + Usual Medical Care vs Usual Medical Care.

Outcome: Respiratory rate (bpm) - 3 hours post intervention.

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>NPPV</th>
<th>UMC</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorokisky 2003</td>
<td>15</td>
<td>15</td>
<td>-3.20 [ -5.74, -0.66 ]</td>
<td>0.0%</td>
<td>0.0 [ 0.0, 0.0 ]</td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td><strong>0</strong></td>
<td><strong>0</strong></td>
<td><strong>0.0 %</strong></td>
<td><strong>0.0 [ 0.0, 0.0 ]</strong></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable.

Test for overall effect: Z = 0.0 (P < 0.00001).

**WHAT’S NEW**

Last assessed as up-to-date: 9 May 2005.

2 July 2008 Amended Converted to new review format.

**HISTORY**


10 May 2005 New citation required and conclusions have changed Substantive amendment

**CONTRIBUTIONS OF AUTHORS**

Previous authors: Felix Ram initiated the idea of this review and wrote the protocol and updated the review in May 2005. Sheree Wellington assisted with assessment of studies and data extraction.

BR was the assigned Cochrane group editor who also helped with the writing up of the review. JW assisted with manuscript preparation.
DECLARATIONS OF INTEREST

There are no known conflicts of interest.

INDEX TERMS

Medical Subject Headings (MeSH)
Acute Disease; Asthma [*complications]; Positive-Pressure Respiration [*methods]; Randomized Controlled Trials as Topic; Respiratory Insufficiency [etiology; *therapy]

MeSH check words
Adult; Humans