# Negative Pressure Ventilation for Acute and Acute-on-Chronic Respiratory Failure

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## Introduction

Respiratory failure is the commonest organ failure seen in the ICU[1] and is managed with non-invasive or invasive positive pressure ventilation (PPV). Negative pressure ventilation (NPV) could offer a safe and effective alternative, however existing devices, such as the iron lung, are heavy and access to the patient for ongoing care is a limitation. However, a new, light-weight negative pressure ventilator is now available that is safe and effective in a healthy volunteer trial[2]. This device offers a practical alternative to PPV. They are cheaper to manufacture and do not require a pressurised gas supply. Therefore, they could potentially be used in Low- and Middle-Income Countries where acute and acute-on-chronic respiratory failure continue to cause significant morbidity and mortality[3].

**Potential Benefits of NPV: less ventilator-induced lung injury[4]; an increased cardiac output[5]; decreased pulmonary vascular resistance[6]**

**Study Objective:** To address whether acute or acute-on-chronic respiratory failure in hospitalised adults can be safely and effectively managed with NPV.

Figure 1: Modern negative pressure ventilator

## Methodology

The protocol for this systematic review was registered with the international prospective register of systematic reviews (ID CRD420200220881). MEDLINE, EMBASE, CENTRAL, medRxiv, bioRxiv and Trip databases were searched (inception to 22nd April 2021).

Two authors (RE, JVP) independently screened for potentially eligible studies using Rayyan Intelligent Systematic Review Software and the same two authors then reviewed the full texts of those deemed potentially eligible. Data extraction was then carried out by RE and independently checked by JVP.

Where appropriate a pooled effect estimate was carried out with variable summarised as weighted mean difference and results displayed as forest plots.

## Results

575 unique citations were screened with 14 meeting inclusion criteria. 1032 acute episodes (888 patients) of respiratory failure were managed with NPV, with 234 receiving PPV as a comparator. The majority (n=845, 66.7%) were treated for an acute exacerbation of COPD. 417 patients from four studies were included in the meta-analysis.

**The effect of NPV on $PaCO_2$ (see figure 2), pH and $PaO_2/FiO_2$ was similar to PPV with a mean difference -0.39kPa (95% confidence interval (CI): -0.95, 0.18), 0.01 (95% CI: 0.00, 0.02), and -0.16 (95% CI: -1.98, 1.66) respectively.**

Of those studies not included in the meta-analysis six showed a statistically significantly increase in $PaO_2$ with the use of NPV and five showed a statistically significant improvement in $PaCO_2$. Rates of complications were similar with NPV in those studies that compared it to PPV, and NPV appeared to be well tolerated by patients. This systematic review study was limited by a wide range of study designs.

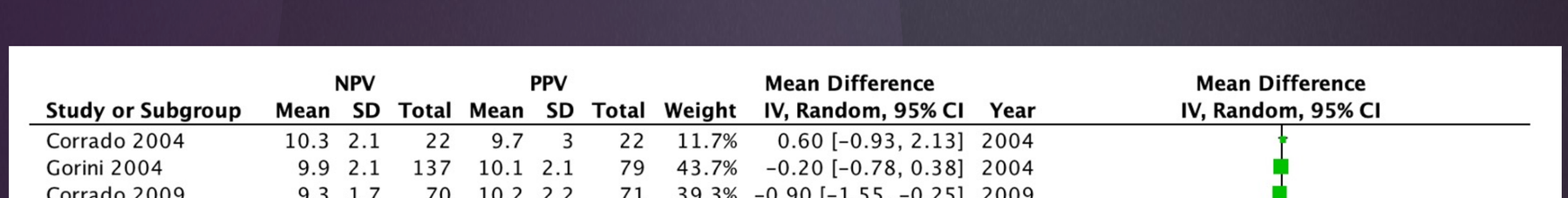


Figure 2: Forest plot comparing effects of NPV and PPV on PaCO2

## Conclusions

NPV appears to be a safe and effective alternative to PPV in the management of acute exacerbation of COPD

Evidence for its use in other forms of respiratory failure is limited but warrants further investigation

## References

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