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Efficacy of noninvasive ventilation after planned extubation: A systematic review and meta-analysis of randomized controlled trials

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ABSTRACT

The objective our meta-analysis is to update the evidence on the efficacy of noninvasive ventilation (NIV) compared with conventional oxygen therapy after planned extubation. We did a systematic literature review of database, including Pubmed, EMBASE, and Cochrane. We included randomized controlled trials comparing NIV with conventional oxygen therapy after planned extubation in medical intensive care unit (ICU) in our analysis. The results of our meta-analysis is consistent with the results of previous reviews and show that NIV decreased reintubation rate significantly as compared to conventional oxygen therapy in chronic obstructive pulmonary disease (COPD) and patients at high risk for extubation failure; COPD (RR, 0.33; 95% CI, 0.16–0.69; I2 = 0), high risk (RR, 0.47; 95% CI, 0.32–0.70; I2 = 0). However, in a mixed medical ICU population, there was no statistical difference of reintubation rate between the two groups (RR, 0.66; 95% CI, 0.25–1.73; I2 = 68%). Our study suggests that use of NIV after planned extubation significantly decreases the reintubation rate in COPD patients and patients at high risk for extubation failure, confirming the findings of previous reviews. There is no difference in the reintubation rate between the two groups in the mixed medical ICU population.

Introduction

Mechanical ventilation is often necessary in patients with acute respiratory failure. Invasive mechanical ventilation [IMV] is associated with various complications such as ventilator associated pneumonia (VAP), sinusitis, pharyngo-laryngeal dysfunction, and laryngeal injuries.[1] Minimizing the duration of IMV could potentially improve patient outcomes. Noninvasive ventilation (NIV) can be an effective strategy in acute respiratory failure in patients with chronic obstructive pulmonary disease [COPD] exacerbations and cardiogenic pulmonary edema, and several studies reported good clinical outcomes including mortality.[2–6] In recent years, its use has been extended to patients who are on IMV, either to facilitate early weaning of the patients from IMV or treatment of respiratory failure that developed after extubation or as a transition to spontaneous breathing after planned extubation. NIV has been shown to facilitate early extubation in COPD patients [Canadian guidelines: Level of recommendation, 2B].[6–8] However, results are disappointing in patients in whom NIV was used after they developed respiratory failure.[6,9] Thus, it would be better if NIV is applied immediately after planned extubation before respiratory failure developed to prevent reintubation. Studies reported reintubation rates as high as 20% after planned extubation.[10–13] Reintubation is associated with higher mortality, ICU and hospital length of stay and VAP.[14] Reintubation is an independent predictor of mortality, even after adjustment for severity of disease and coexisting conditions.[14] In critically ill patients, early weaning with NIV has been shown to decrease mortality, VAP and length of stay, particularly in patients with COPD.[13,14] Most of the studies done on the use of NIV after planned extubation were small, randomized controlled trials [RCTs] and evidence is still lacking in mixed medical ICU population. In a small review done by Keenan et al, NIV decreases the reintubation rate (RR = 0.42 [CI: 0.25–0.70]) and ICU mortality (RR = 0.35 [CI: 0.16–0.78]) after planned extubation in patients at high risk for extubation failure when compared to patients with

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conventional oxygen therapy.[6] In another recent review by Lin et al, the use of NIV after planned extubation in medical ICU patients decreases the reintubation rate in the NIV group as compared to the conventional oxygen therapy group.[15]

We aimed to update the meta-analysis by adding three additional studies to Lin et al's meta-analysis to provide clear evidence on use of NIV after planned extubation in medical ICU patients. We also aimed to do a separate analysis on three different subgroups: COPD, at high risk for extubation failure and mixed ICU, which was not done in previous reviews to evaluate if there are particular groups of patients in which NIV is more effective.

Methods

Data source and searches

A systematic search of Medline, EMBASE, Cochrane Database of Systematic reviews and Cochrane Central Register of Controlled Trials were performed. The following keywords were used in various combinations, "Noninvasive ventilation," "noninvasive positive pressure ventilation," "BiPAP," "CPAP and extubation." Additionally, references from previous trials, meta-analysis and the web base were searched to identify any relevant studies. No language restriction was enforced. The abstracts or manuscripts of all retrieved studies cited before February 2014 were reviewed [Fig. 1].

Study selection

The inclusion criteria were based on the following attributes: 1) Design: randomized controlled trial; 2) Population: Adult patients admitted in medical ICU for acute respiratory failure and on mechanical ventilation for >48–72 h and electively extubated; 3) Intervention: Noninvasive ventilation versus conventional oxygen therapy post-extubation; 4) Outcomes: reintubation rate, ICU mortality, hospital mortality and ICU length of stay.

Exclusion criteria: 1) Informed consent not available, 2) gastric or esophageal surgery, 3) gastrointestinal bleeding, 4) pregnancy, 5) contraindications for NIV: facial abnormalities, upper airway obstruction, excessive amount of respiratory secretions, uncooperative state.

Treatment groups

NIV group

The noninvasive ventilation was delivered using a BiPAP along with oxygen. Initial settings ranged from inspiratory positive airway pressure (IPAP) 8–16 cm H_2O/expiratory positive airway pressure (EPAP) 4–6 cm H_2O. The settings were adjusted later based on values of PaO_2 and $PaCO_2$.

Conventional oxygen therapy group: oxygen was delivered using a face mask or venture mask. The oxygen concentration was titrated to keep $SaO_2 > 90\%$.

Data extraction and validity assessment

Two reviewers [AB and PR] independently performed the literature search and identified relevant studies. Relevant data on study design, patient population, inclusion and exclusion criteria, mean age, reintubation criteria, comparison and outcomes were extracted. A third investigator was available for arbitration in the event of discordance of the extracted data, but no significant disagreement was encountered.

Definitions

High risk group[7]

a) Older than 65 years of age, Cardiac failure as the cause of intubation or APACHE score >12 at the time of extubation, b) More than one of the following: failure of consecutive weaning trials, chronic cardiac failure, $PaCO_2$>45 mm Hg at the time of extubation, more than one noncardiac comorbidity, weak cough or stridor after extubation not needing immediate reintubation, c) acute exacerbation of COPD, and d) history of chronic respiratory disorders with mechanical ventilation >48 h and hypercapnia during spontaneous breathing trial.

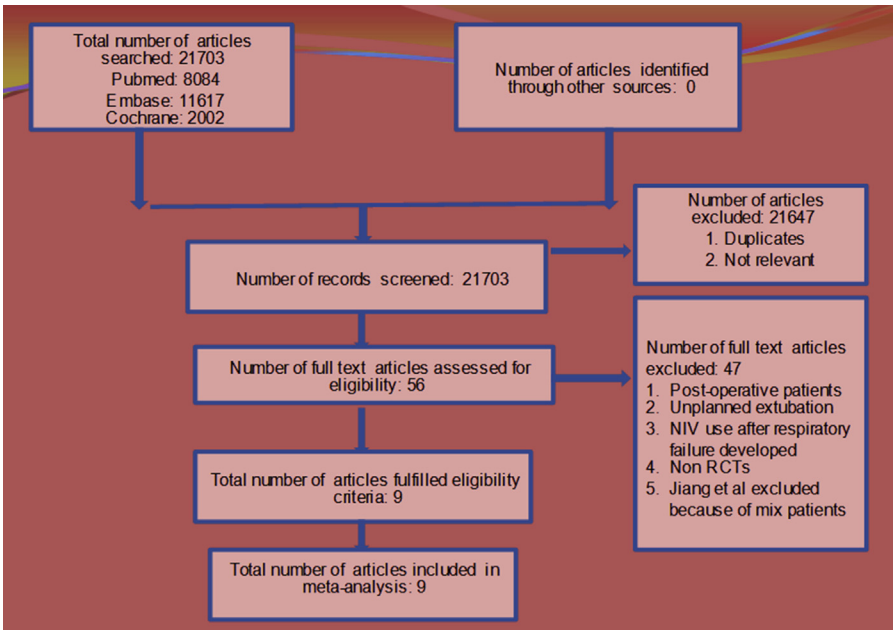

Fig. 1. Prisma (Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement). Diagram for systematic search of studies. RCT = randomized controlled trial, NIV = noninvasive ventilation.