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The efficacy of noninvasive ventilation in managing postextubation respiratory failure: A meta-analysis

Changyang Lin, Dr, Huapeng Yu, MD *, Huizhen Fan, Dr, Zhongli Li, Dr

Department of Respiratory Disease, Zhujiang Hospital, Southern Medical University, 253 Gongye Avenue, Guangzhou, Guangdong, China

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ABSTRACT

Introduction: To determine the effectiveness of noninvasive ventilation (NIV) in the management of postextubation respiratory failure.

Methods: Databases including PubMed, EMBASE, and the Cochrane Central Register of Controlled Trials were searched to find relevant trials. Randomized and quasi-randomized trials studying NIV in adult patients with postextubation respiratory failure were included. Effects on primary outcomes (i.e., reintubation rate, and ICU or/and hospital mortality) were accessed in this meta-analysis.

Results: Ten trials involving 1382 patients were included: two used NIV in patients with established postextubation respiratory failure, and eight used NIV immediately after extubation. The use of NIV following extubation for patients ($n = 302$) with established respiratory failure did not decrease the reintubation rate (relative risk [RR] 1.02, 95% confidence interval [CI] 0.83–1.25) and ICU mortality (RR 1.14, 95% CI 0.43–3.00), compared to standard medical therapy (SMT). Early application of NIV after extubation ($n = 1080$) also did not decrease the reintubation rate (RR 0.75, 95% CI 0.45–1.15) significantly. However, in the planned extubation subgroup ($n = 849$), there were significant reductions in the reintubation rate (RR 0.65, 95% CI 0.46–0.93), ICU mortality rate (RR 0.41, 95% CI 0.21–0.82), and hospital mortality rate (RR 0.59, 95% CI 0.38–0.93) compared to SMT.

Conclusion: Current evidence suggests that the use of NIV in patients with established postextubation respiratory failure should be monitored cautiously. Early use of NIV can benefit patients with planned extubation by decreasing the reintubation rate and the ICU and hospital mortality rates.

Introduction

Invasive mechanical ventilation (IMV) is a rescue procedure for patients with acute respiratory failure of different etiologies. Weaning a patient from mechanical ventilation is essential to the success of the procedure. However, reintubation due to extubation failure is common, with a prevalence ranging from 10 to 19%.[1–3] Extubation failure prolongs the duration of mechanical ventilation, extends the length of the ICU and hospital stay, increases the need for tracheostomy, and is associated with high hospital mortality.[4,5] Moreover, prolonged mechanical ventilation increases the cost of care. Therefore, methods are needed to predict extubation outcomes accurately and to prevent the development of respiratory failure after extubation and subsequent reintubation.

Noninvasive ventilation (NIV) has been widely used to treat acute respiratory failure of different etiologies,[6] including exacerbation of chronic obstructive pulmonary disease (COPD)[7,8] and cardiogenic pulmonary edema,[9] which decreases the need for IMV. Recently, there has been increasing interest in the use of NIV during the postextubation period to shorten the length of invasive ventilation, to prevent extubation failure, and to rescue failed extubation.[10–14] Moreover, at an international consensus conference, NIV was suggested to be a promising therapy after extubation failure to avoid reintubation.[14] At present, however, the role of NIV in preventing extubation failure and reintubation is unclear.

Therefore, the aim of this meta-analysis was to analyze the efficacy of NIV in managing patients with respiratory failure after extubation, with a focus on the preventive and therapeutic effects of NIV.

Methods

Search strategy and selection criteria

We searched the PubMed, EMBASE, the Cochrane Central Register of Controlled Trials databases for articles published

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* Corresponding author. Tel./fax: +86 (0)20 6164 3175.
E-mail address: Huapengyu123@126.com (H. Yu).

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through July 2013 in any language. The search strategies applied the following key words: noninvasive ventilation, noninvasive positive pressure ventilation, NIV, BIPAP, wean, weaning, mechanical ventilation, NIPPV, extubation, postextubation, and respiratory failure. Additional data sources were examined, including conference proceedings and the reference lists of relevant studies. All databases were checked daily for newly updated studies.

Studies fulfilling the following selection criteria were included in this meta-analysis: (1) the study design was a randomized controlled trial (RCT), (2) the study population was adult patients receiving IMV for acute respiratory failure of different etiologies (COPD, persistent asthma, cardiac pulmonary edema, acute respiratory distress syndrome [ARDS], bronchiectasis, and pulmonary tuberculosis) for at least 48 h, (3) the intervention was NIV after extubation versus standard medical therapy (SMT), and (4) the study reported outcomes for reintubation rate and/or mortality, including ICU mortality and hospital mortality.

Trials were excluded if (1) the participants did not receive IMV, the participants received postoperative intubation, or the age of the subjects was $\leq$19 years, (2) the intervention was early extubation with immediate application of NIV when patients met weaning criteria. Control ones were weaned conventionally; (3) the trial was published as an abstract only.

Study selection

The process of identifying relevant trials is shown in Fig. 1. A total of 813 studies were retrieved. After removing duplicate records, there were a total of 673 studies. During the selection process, 614 studies were excluded because they did not focus on the use of NIV after extubation, and 27 studies were excluded because they were review or commentary articles. After the full-text articles were assessed for eligibility, 22 studies were excluded. Of these 22 studies, 12 studies enrolled pediatric patients, nine studies were not RCTs, and one study was published as an abstract only. Subsequently, 10 RCTs were included in the qualitative and quantitative analysis.

Data collection process

Two authors independently reviewed the full manuscripts of the eligible trials, and the relevant data were extracted into predesigned data collection forms. We verified the accuracy of the data by comparing the collection forms from each reviewer. Any discrepancy was resolved by discussion, or a third author would assess these articles. The following data were collected from each study: first author, year of publication, study design, location, sample size, participant demographics, timing of NIV, whether patients passed a spontaneous breathing trial (SBT) before extubation, and outcome variables. Authors of the included studies were contacted via e-mail if further study details were needed.

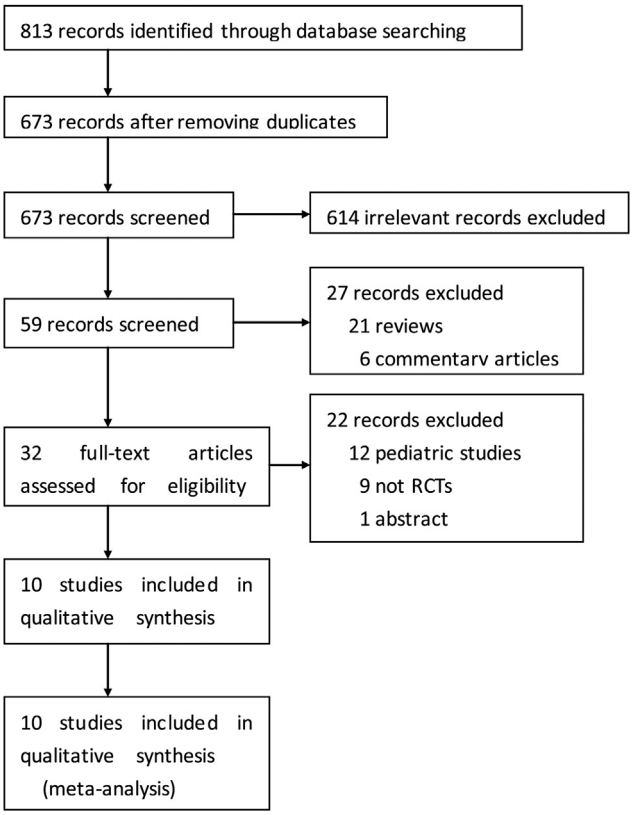

Fig. 1. Diagram illustrating the process for identifying relevant trials.

Qualitative assessment

Methodological quality assessment was independently performed by two of the authors, and any disagreement was resolved by consensus. Risk of bias was evaluated as high, low, or unclear using the Cochrane Risk of Bias Tool for RCTs.

Statistical analysis

Reintubation, ICU mortality, and hospital mortality were analyzed using the Mantel–Haenszel (M-H) method to calculate

Table 1
Characteristics of included trials.

Author	Year	Location	Trial type	NIV		Control		Extubation
				No. of patients	Mean age (y)	No. of patients	Mean age (y)	
Jiang	1999	Taiwan	Single center	47	73.4	46	72.1	Partly
Keenan	2002	Canada	Single center	39	68.3	42	68.6	NS
Esteban	2004	US[a]	Multicenter	114	61.0	107	58.0	Elective
Nava	2005	Italy	Multicenter	48	56.0	49	53.2	Elective
Ferrer	2006	Spain	Multicenter	79	72.0	83	70.0	Elective
Ferrer	2009	Spain	Multicenter	54	67.0	52	70.0	Elective
Girault	2011	France[b]	Multicenter	69	71.0	70	72.0	Unplanned
Khilnani	2011	India	Single center	20	62.0	20	58.4	Elective
Su	2012	Taiwan	Multicenter	202	64.6	204	63.3	Elective
Ornico	2013	Brazil	Single center	20	50.8	18	48.9	Elective

[a] Study conducted in US, Spain, Canada, Saudi Arabia, Italy, Venezuela, and Argentina.
[b] Study conducted in France and Tunisia.