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REVIEW ARTICLES

Non-invasive ventilation for weaning, avoiding reintubation after extubation and in the postoperative period: a meta-analysis

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Editor's key points

- The role of non-invasive ventilation (NIV) to aid weaning and avoid reintubation has been studied in the past.
- This meta-analysis selected 16 relevant randomized controlled trials.
- The use of NIV reduced the length of stay in intensive care unit and the rate of reintubation.
- This important meta-analysis provides strong evidence in favour of using NIV during weaning from mechanical ventilation.

Summary. Non-invasive ventilation (NIV) is a supportive therapy that improves mortality in acute respiratory failure (RF). It may also be used in patients recently extubated in intensive care units (ICUs), after operation, and to aid weaning from mechanical ventilation (MV) by reducing the morbidity and mortality associated with further MV. A meta-analysis of the available evidence was performed on the use of NIV in three areas: weaning, reduction in reintubation rates post-extubation on ICU, and reduction in RF after major surgery. Sixteen relevant randomized controlled trials were identified by three reviewers after a detailed search of identified medical databases. A meta-analysis of summary statistics relating to predetermined endpoints (ICU and hospital length of stay, ICU and hospital mortality, reintubation, pneumonia) was performed. NIV reduced the ICU length of stay when used for weaning (5.12 days) and post-surgery (0.44 days). NIV reduced reintubation rates post-surgery [odds ratio (OR) 0.24, 95% confidence interval (CI) 0.12–0.50] and the incidence of pneumonia in weaning (OR 0.12, 95% CI 0.05–0.31) and post-surgery (OR 0.27, 95% CI 0.09–0.77). There was insufficient evidence to suggest that NIV improves ICU survival, but an increased hospital survival in weaning (OR 0.55, 95% CI 0.31–0.98) and post-surgery (OR 4.54, 0.95% CI 1.35–15.31) was seen. A meta analysis of NIV use in selected subgroups of recently extubated patients suggests that the judicious NIV use may reduce ICU and hospital length of stay, pneumonia, and reintubation rates and hospital survival.

Keywords: complications, respiratory; intensive care, pulmonary; mechanical ventilation; weaning

Tracheal intubation and mechanical ventilation (MV) are supportive interventions that may be life saving in critically ill patients but also introduce significant risk of morbidity and mortality, including volutrauma, barotrauma, ventilator-associated pneumonia (VAP), and the complications associated with sedation. VAP is associated with poor clinical and economic outcomes, with a large data registry series from the USA quoting rates of VAP in ventilated intensive care unit (ICU) patients of 9.3% and demonstrating increased morbidity and ICU length of stay.[1] Timely extubation is one way of minimizing this morbidity,[2] but premature or inappropriate extubation may in itself be detrimental, and the need for reintubation may be associated in some patient groups with a hospital mortality of up to 40%.[3]

Non-invasive ventilation (NIV) refers to the delivery of ventilatory support via the patient's upper airway using a mask or similar device.[4] Non-invasive respiratory support ranges from basic continuous positive airway pressure (CPAP) to non-invasive positive pressure ventilation (NPPV) in which varying levels of pressure support can be applied during patient inspiration. The use of NIV has increased considerably over the last 20 yr as a viable alternative to tracheal intubation and MV in patients with respiratory failure (RF). It has been demonstrated to reduce the need for tracheal intubation[5] and ventilation in several patient groups,[6] including exacerbations of chronic obstructive pulmonary disease (COPD),[7] cardiogenic pulmonary oedema,[8] the immunocompromised,[9] and those in whom invasive MV has been deemed inappropriate.[10]

More recently, NIV has been used in a wider variety of clinical situations, such as ICU patients who have recently been extubated after a period of MV,[11] patients who are difficult to wean from MV,[12] and postoperative surgical patients.[13] This population of recently extubated patients all have increased morbidity and mortality should they develop RF and require

reintubation and may therefore benefit from the use of NIV to prevent this progression. Results of studies examining the use of NIV in these situations in the general critical care population have been inconclusive, and there remains no clear consensus opinion regarding the use of NIV after extubation. Many of the trials also focus on patient mortality as their primary endpoint and apportion less attention to the impact that NIV may have on important health economic outcomes such as ICU and hospital length of stay and rates of nosocomial pneumonia.

Therefore, we performed a systematic review and meta-analysis of the currently available literature on the use of NIV after extubation, specifically considering patients difficult to wean from MV, patients in the immediate postoperative period, and critically ill patients within the ICU with the aim of assessing the potential benefits that the use of NIV may have in these situations compared with standard medical therapy.

Methods

Papers were identified from a literature search of Ovid Medline, NHS Evidence Embase, Web of Science, and The Cochrane Library and DARE libraries for various different key phrases and restrictions to identify randomized control trials (RCTs) reported in English that looked at using NIV in either post-extubation, weaning, or postoperative patient populations compared with standard care. The interchangeable use of the term 'NIV'—which in some instances referred to solely NPPV and in others both NPPV and CPAP—did raise some difficulties in performing the searches. We were unable to identify any studies in adult populations where CPAP was used in post-ICU extubation and weaning patients; however, the use of CPAP is more prevalent than NPPV in postoperative populations. For this reason, we ran a second search of postoperative patients using the search term 'continuous positive airways pressure' to ensure that any studies performed in this area were not excluded from our analysis. For the purposes of analysis, we subdivided the papers into three subgroups in which NIV may be used in recently extubated patients, namely post-extubation in ICU, weaning of patients from MV, and postoperative patients. Table 1 gives the details of the search strategies used and the results obtained.

Each identified paper was reviewed and assessed independently by three clinicians against the following criteria for inclusion:

- Searches repeated by three authors (A.J.G., D.C.B., and G.H.M.).
- Papers identified that related directly to the use of NIV post-ICU extubation, in weaning, or in postoperative patients.
- Of the remaining papers, only those that reported RCTs were retained for inclusion.

Table 1 Search strategies used and results obtained

	Search term	Database				
		Ovid Medline (1950–2012)	NHS Evidence EMBASE	Web of Science	Cochrane	DARE
1	Intubation intratracheal	26 162	−216	0	—	—
2	Respiration artificial	47 870	—	1643	—	—
3	Respiratory insufficiency	43 817	—	3702	—	—
4	Weaning/ventilator weaning 9199	—	19 936	—	—	—
5	Positive pressure respiration 16 519	—	—	—	—	—
6	1 or 2 or 3 or 4 or 5	110 778	—	—	—	—
7	Non-invasive ventilation	715	2028	2409	2	13
8	6 and 7	658	—	—	—	—
9	Limit 8 to abstracts and English language and years 1980–present and clinical trials	80	—	—	—	—
10	1 or 2 or 3 or 5	103 737	—	—	—	—
11	Continuous positive airways pressure	1931	—	—	—	—
12	Postoperative complications 335 016	—	—	—	—	—
13	1 and 10 and 11 81	—	—	—	—	—
14	Artificial ventilation	20 915	—	—	—	—
15	7 and 14	925	—	—	—	—
16	Limit 15 to abstracts and humans >18 yr	—	307	—	—	—
17	Controlled clinical trial >100 000	— —	181 320 —			
18	15 and 17	—	62	—	—	—
19	1 or 2 or 3	—	24 540	—	—	—
20	7 and 19	—	—	377	—	—
21	20 excluding paediatrics and neurological disorders and English only	—	216	—	—	—
22	17 and 18	—	—	39	—	—