

Systematic Review Snapshot

TAKE-HOME MESSAGE

Noninvasive ventilation in chest trauma patients may reduce the requirement for intubation and may reduce mortality.

METHODS

DATA SOURCES

A computerized search of MEDLINE and EMBASE was performed to identify studies for meta-analysis. Databases were searched from inception until July 2012. Subsequently, the references of selected articles were reviewed to identify additional potentially eligible studies.

STUDY SELECTION

Studies included randomized controlled trials, prospective observational trials, and retrospective observational studies that enrolled adults with chest trauma who developed mild to severe acute respiratory failure; were admitted to a trauma service, emergency department (ED), or ICU; and were treated with a noninvasive ventilation strategy. Noninvasive ventilation was defined as continuous positive airway pressure, bilevel positive airway pressure, or noninvasive intermittent-pressure support ventilation. The trials chosen studied at least 1 of the following outcomes: mortality, intubation rate, complications, infections, ICU length of stay, hospital length of stay, gas exchange, or respiratory rate. Noninvasive ventilation was compared with standard care, ie, mechanical ventilation or

Does Noninvasive Ventilation Have a Role in Chest Trauma Patients?

EBEM Commentators

Angela Hua, MD

Kaushal H. Shah, MD

Department of Emergency Medicine

Mount Sinai Medical Center

New York, NY

Results

Effect of noninvasive ventilation on chest trauma patients versus standard care.

Outcome	N	RR/WMD (Compared With Standard Care)	95% CI	I ² , %
Mortality	5	RR=0.26	0.09 to 0.71	0
Intubation rate	2	RR=0.32	0.12 to 0.86	0
Length of ICU stay	4	WMD=-2.4	-3.9 to -1.0	53.3
Arterial oxygenation	5	WMD=101.0	10.6 to 191.5	n/a
Complications	4	RR=0.37	0.20 to 0.57	0
Infections	3	RR=0.34	0.20 to 0.58	0

N, Number of studies per analysis; RR, relative risk; WMD, weighted mean difference; CI, confidence interval; n/a, not available.

After review of 263 articles, 10 studies (observational and randomized control trials) were included for the meta-analysis, totaling 368 patients. These studies enrolled patients admitted to ICUs and EDs in different countries: Italy, United States, Spain, Greece, South Africa, Turkey, and Australia.

Five studies (219 patients) reported mortality. The results showed a 3.0% (3/101) mortality in the noninvasive ventilation group compared with 22.9% (27/118) in the control group, which included both intubated patients and those treated with passive oxygenation, with no heterogeneity across studies. Noninvasive ventilation was also associated with a significantly reduced intubation rate,

lower overall complications, and shorter length of ICU stay.

Commentary

Chest trauma composes 10% to 15% of all traumas and is responsible for 17% to 25% of all deaths caused by trauma.^{1,2}

For decades, invasive mechanical ventilation has been posited to be the only route of ventilator support to improve gas exchange, and it has been used in up to 50% of patients with significant chest trauma.³ Although intubation and mechanical ventilation can be lifesaving, they can also induce barotrauma, ventilator-associated infections, and other adverse events.⁴ Noninvasive ventilation has similarly been shown to reduce work of breathing and improve

unassisted supplemental oxygen therapy.

DATA EXTRACTION AND SYNTHESIS

Three reviewers screened citation titles and abstracts independently; disputes were reviewed by the authors until consensus was reached for inclusion. Data were collected in a datasheet, including publication, study design, number of patients enrolled, and outcomes. A DerSimonian and Laird random-effect model was used for the meta-analysis; relative risk was calculated for dichotomous outcomes, and mean weighted difference was calculated for continuous outcomes. The risk of publication bias was assessed with funnel plots and statistical analyses, using Stata (version 12; StataCorp, College Station, TX). The I^2 statistic was used to measure heterogeneity across studies. A sensitivity analysis based on quality was not conducted.

gas exchange, without the associated complications from intubations; it has been particularly effective for patients with chronic obstructive pulmonary disease exacerbation and cardiogenic pulmonary edema.⁵

In this systematic review, 4 of the 5 studies addressing mortality found a reduction in mortality rate for chest trauma patients with the use of noninvasive ventilation. Noninvasive ventilation's effect on mortality seemed unrelated to the treatment modality (continuous positive airway pressure, bilevel positive airway pressure, and noninvasive intermittent-pressure support ventilation), suggesting the benefit derives from positive-pressure ventilation. It is thought that noninvasive ventilation increases transpulmonary

pressure, recruiting collapsed and poorly ventilated lung regions, thereby reducing the work of breathing and ameliorating gas exchange. This review indeed found improved gas exchange and oxygenation in trauma patients. One concern raised was the risk of tension pneumothorax from positive-pressure ventilation because lung contusions from chest trauma are frequently associated with pneumothorax. The meta-analysis found no significant associated increase in the incidence of pneumothorax with noninvasive ventilation.

There are several limitations in this meta-analysis. First, and most important, there was no set standard criterion for use of noninvasive ventilation in chest trauma across the various studies; therefore, it is not entirely clear exactly when and for whom noninvasive ventilation should be initiated.

Second, the number of eligible studies included in the analysis was relatively small (10 studies; 368 patients); fortunately, 4 of the 10 studies were randomized controlled trials, but the other 6 were observational studies.

Third, because of the paucity of studies, it was not possible to separate the effects of continuous positive airway pressure, bilevel positive airway pressure, and noninvasive intermittent-pressure support ventilation. Because of these limitations, there was a high heterogeneity of effect across studies for a number of variables. However, for the binary outcomes (ie, mortality, complications, infections, intubation rate), which are more pertinent to emergency physicians, there was a high homogeneity among the studies.

Fourth, an important limitation is the inherent selection bias with noninvasive ventilation treatment insofar as

patients must be able to tolerate the noninvasive ventilation apparatus. Patients who are obtunded or too severely in respiratory distress to tolerate noninvasive ventilation are excluded from that strategy. Thus, the patients who are intubated may be more critically ill and therefore have higher mortality rates.

Overall, this meta-analysis suggests that early use of noninvasive ventilation in chest trauma patients may reduce mortality and the intubation rate without increasing complications. However, further studies are needed to better define the patient selection criteria and timing for noninvasive ventilation, as well as to elucidate factors that would predict success or failure on noninvasive ventilation. A randomized controlled trial of noninvasive ventilation for validation would be ideal before it can be incorporated into daily clinical practice for chest trauma patients.

Editor's Note: This is a clinical synopsis, a regular feature of the *Annals'* Systematic Review Snapshot (SRS) series. The source for this systematic review snapshot is: Chiumello D, Coppola S, Froio S, et al. Noninvasive ventilation in chest trauma: systematic review and meta-analysis. *Intensive Care Med.* 2013;39:1171-1180.

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Michael Brown, MD, MSc, Alan Jones, MD, and David Newman, MD, serve as editors of the SRS series.