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What is the Impact of Low Tidal Volume Ventilation for Emergency Department Patients?

TAKE-HOME MESSAGE

Among emergency department patients, low tidal volume ventilation is associated with reduced mortality, lower rates of developing acute respiratory distress syndrome, and more ventilator-free days.

METHODS

DATA SOURCES

The authors searched MEDLINE, Embase, Scopus, Cochrane Central Register of Controlled Trials, and Cochrane Database of Systematic Reviews from inception to May 2021 for relevant studies. The authors also manually searched the abstracts presented at select emergency medicine and critical care conferences from 2016 to 2021 and the reference lists of the included articles. They searched ClinicalTrials.gov to identify completed but not yet published studies. Individual study investigators were contacted for additional data as needed.

STUDY SELECTION

The inclusion criteria consisted of randomized and nonrandomized studies of adult emergency department (ED) patients receiving mechanical ventilation. There were no language restrictions. Case studies, reviews, correspondences, and editorials were not eligible. Two independent reviewers screened abstracts with disagreements resolved by a third reviewer.

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This review does not reflect the views or opinions of the U.S. government, Department of Defense, U.S. Army, U.S. Air Force, Brooke Army Medical Center, or SAUSHEC EM Residency Program.

Jestin N. Carlson, MD, MS, Alan Jones, MD, and Michael Gottlieb, MD, serve as editors of the SRS series. Dr. Jones was the supervising editor on this article. Dr. Gottlieb did not participate in the editorial review or decision to publish this article.

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: **De Monnin K, Terian E, Yaegar LH, et al. Low tidal volume ventilation for emergency department patients: a systematic review and meta-analysis on practice patterns and clinical impact. *Crit Care Med.*** Published online February 7, 2022. https://doi.org/10.1097/ccm.0000000000005459

Results

Table. Low tidal volume ventilation outcomes.

Outcome	Number of Studies (Number of Patients)	Result (95% CI)	Heterogeneity (I^2)
Mortality	10 (11,086)	OR 0.87 (0.69 to 1.09)	76%
Mortality with leave-one-out analysis	9 (8,127)	OR 0.80 (0.72 to 0.88)	0%
ARDS occurrence rate	5 (7,042)	OR 0.57 (0.44 to 0.75)	21%

Included studies compared outcomes between patients receiving ED low tidal volume ventilation and nonlow tidal volume ventilation (defined as tidal volume >8 mL/kg predicted body weight). The primary outcome was hospital mortality. Secondary outcomes included the duration of mechanical ventilation, length of stay in the ICU, length of stay at the hospital, and the occurrence rate of acute respiratory distress syndrome after admission.

DATA EXTRACTION AND SYNTHESIS

The authors conducting the meta-analysis extracted study characteristics and assessed quality with the Newcastle-Ottawa Scale.[1] Pooled effect sizes and 95% confidence intervals were calculated using random effects modeling. Tidal volumes were compared using an independent sample *t* test. Odds ratios were calculated for binary outcomes. Continuous variables were reported as mean differences, and overall effect estimates were generated using a *Z* test. Heterogeneity was assessed with I^2. After evaluation, a "leave-one-out" analysis was also completed because one study contributed nearly all the heterogeneity seen in the pooled analysis. Publication bias was assessed using a funnel plot.

Table. Continued.

Outcome	Number of Studies (Number of Patients)	Result (95% CI)	Heterogeneity (I^2)
Hospital LOS	7 (10,163)	MD −1.2 days (−2.3 to −0.1)	63%
ICU LOS	7 (10,163)	MD −1.0 days (−1.7 to −0.3)	82%
Ventilator-free days	7 (7,122)	MD 1.4 days (0.4 to 2.4)	58%

ARDS, Acute respiratory distress syndrome; *CI,* confidence interval; *LOS,* length of stay; *MD,* mean difference; *OR,* odds ratio.

The literature search identified 652 unique studies, of which 21 were included in the final analysis, with 11 studies (n=12,912) providing outcome data for meta-analysis and 10 studies (n=1,863) providing descriptive tidal volume data. The 11 studies providing outcome data were published between 2016 and 2021. Of these, there were 3 quasi-experimental before-after studies, 2 retrospective before-after studies, and 6 cohort studies. Nine studies were conducted in the United States, and 2 studies were conducted in Canada. Eight studies were considered good quality on the basis of the Newcastle-Ottawa Scale, with 3 rated as poor quality. Low tidal volume ventilation was not associated with reduced mortality in a pooled analysis of 10 studies; however, the sensitivity analysis with exclusion of the outlier study found resolution of the heterogeneity and a reduced mortality rate (Table). Low tidal volume ventilation was also associated with a reduced rate of acute respiratory distress syndrome occurrence and more ventilator-free days, but no difference in length of stay.

Commentary

Critically ill patients requiring mechanical ventilation have high rates of morbidity and mortality.[2,3] Lung-protective ventilation (which includes low tidal volume ventilation) has demonstrated benefit in patients with and without acute respiratory distress syndrome.[4,5] However, this has traditionally focused on the ICU population. Recent literature has suggested that this benefit may be extended to the ED setting, particularly because these patients may have a prolonged length of stay.[6,7]

This study found that the use of low tidal volume ventilation in the ED setting was associated with several patient-relevant outcomes, including reduced mortality and progression to acute respiratory distress syndrome.[8] However, it is important to consider several limitations of the review. First, the studies were at risk of confounding because none of the studies were randomized control trials. Additionally, the studies did not account for the impact of post-ED interventions in the ICU setting. There was also significant statistical heterogeneity among several outcomes, and publication bias was present. For the primary outcome of mortality, a difference was only noted after the removal of a large study because of the "leave-one-out" analysis. The removal of outlier studies in this manner is controversial and may result in bias toward an

outcome. The studies only focused on tidal volume and did not assess other parameters of mechanical ventilation. The studies also did not assess other relevant patient-oriented outcomes, such as physical, cognitive, and psychosocial outcomes.

Based on these data, low tidal volume ventilation should be considered as a first-line approach for a mechanically ventilated ED patient, understanding that mechanical ventilation is not a one-size-fits-all model and that it will need to be tailored to the individual patient on the basis of the underlying etiology for their respiratory distress. Future research should evaluate other ventilation management strategies as well as interventions aimed at implementing and sustaining low tidal volume ventilation in the ED setting.

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