Comparison of closed endotracheal suction versus open endotracheal suction in the development of ventilator-associated pneumonia in intensive care patients: an evaluation using meta-analytic techniques

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CRD summary
The review determined the efficacy of closed endotracheal suctioning (CES) compared with open endotracheal suctioning (OES) in the development of ventilator-associated pneumonia (VAP) for mechanically ventilated patients in intensive care. The authors' cautious conclusion, that the current evidence does not appear to support the superiority of CES over OES with respect to VAP or mortality, seems appropriate.

Authors' objectives
To determine the efficacy of closed endotracheal suctioning (CES) compared with open endotracheal suctioning (OES) in the development of ventilator-associated pneumonia (VAP) in mechanically ventilated patients in intensive care.

Searching
MEDLINE and PubMed were searched from 1966 to July 2006 for relevant articles published in English; the search terms were reported. The Cochrane CENTRAL Register was also searched but the search dates were not stipulated. The references of identified articles were also checked.

Study selection
Study designs of evaluations included in the review
Randomised controlled trials (RCTs) were eligible for inclusion.

Specific interventions included in the review
Studies comparing CES with OES were eligible for inclusion. CES was defined as endotracheal suctioning performed without disconnection from the respiratory unit using a multi-use in-line suctioning catheter. OES was defined as endotracheal suctioning performed after disconnection of the respiratory unit using a single-use suctioning catheter under aseptic precautions.

Participants included in the review
Studies of mechanically ventilated adult patients were eligible for inclusion. In the included studies, approximately 60% of the participants were male, the mean age was approximately 53 years, and approximately 60% were medical patients and 40% surgical patients.

Outcomes assessed in the review
Studies that assessed VAP and/or mortality were eligible for inclusion. The primary outcome was VAP rate; definitions for VAP were as used in the included studies. The secondary outcomes included length of stay in the hospital and intensive care unit, mortality (defined as deceased when discharged from hospital) and duration of ventilatory support. Studies reporting only physiological end points were excluded from the review.

How were decisions on the relevance of primary studies made?
One reviewer selected potentially relevant abstracts. Two reviewers then selected studies from identified full papers. It was not reported if the two reviewers selected studies independently.

Assessment of study quality
Two investigators independently assessed the validity of the included studies unblinded to key characteristics (e.g. author name, journal of publication); any disagreements were resolved by consensus. Ten aspects of study quality were assessed: randomisation; allocation concealment; blinding; inclusion and exclusion criteria; baseline comparability of the treatment groups; clear description of study protocol and study entry; influential cointerventions; definitions of outcomes;
description of follow-up; and intention-to-treat analysis. An aggregate score was given for each study (minimum 0 to a maximum 10).

Data extraction
Two investigators independently extracted the data onto standardised data collection forms; any disagreements were resolved by consensus. Risk differences (RDs) were extracted for VAP rates, while weighted mean differences (WMDs) were extracted for all other outcomes.

Methods of synthesis
How were the studies combined?
The studies were combined in a meta-analysis using a fixed-effects model; a random-effects model was used where significant heterogeneity was found. Summary data were reported as a RD for VAP and WMDs for length of stay and duration of ventilation, along with their corresponding 95% confidence intervals (CIs).

How were differences between studies investigated?
Statistical heterogeneity was assessed using the Q statistic (considered significant at \( p \leq 0.1 \)) and the I-squared statistic (substantial heterogeneity if \( I^2 > 50\% \)). A sensitivity analysis using the quality score was also performed. Meta-regression was used to examine the effects of age, percentage males and percentage of medical and surgical patients. A cumulative meta-analysis was used to examine trends in treatment effects over time.

Results of the review
Nine RCTs \((n=1,292)\) were included in the review.

The quality scores of the included studies ranged from 3 to 7 out of 10. Adequate randomisation methods were reported in 3 studies, allocation concealment in one, and the avoidance of potentially influential cointerventions in five. All studies had baseline comparability of the treatment groups but none used blinding or intention-to-treat analysis.

VAP developed in 19.2% of the patients. No significant difference between the treatment groups was found (RD -0.01, 95% CI: -0.05, 0.03), based on 9 RCTs. There was no evidence of statistical heterogeneity. Trial quality was not found to significantly affect this result.

There was no significant difference in overall mortality between the treatment groups: 23.2% in the CES group versus 22.5% in the OES group (RD -0.01, 95% CI: -0.04, 0.05), based on 5 RCTs. There was no evidence of statistical heterogeneity. Trial quality was not found to significantly affect this result.

Duration of ventilation was significantly reduced in the OES group compared with CES (WMD 0.64, 95% CI: 0.21, 1.06), based on 4 studies. One study was shown to substantially contribute to the overall estimate (93%). Trial quality was not found to significantly affect this result. No difference between the treatment groups was found for length of stay in the intensive care unit (WMD -0.90 days, 95% CI: -5.61, 3.81), based on 2 RCTs. There was no evidence of statistical heterogeneity. Hospital length of stay was not reported in any of the included studies.

Cost information
Four studies reported the cost of suctioning. Two studies reported higher costs with closed suctioning, one reported equivocal costs, and the one reported slightly higher costs with open suctioning.

Authors' conclusions
The current evidence does not support the superiority of CES over OES with respect to VAP or mortality, but further clarification is needed.

CRD commentary
The review question was supported by clear inclusion and exclusion criteria. A limited number of sources were searched, the search strategy was restricted by language, and no specific attempts were made to locate unpublished
studies; this might have led to the omission of other relevant studies and it raises the possibility of publication and language bias. The methods undertaken for the data extraction and quality assessment were likely to have minimised reviewer error and bias; however, the authors did not report whether such procedures were employed at the study selection stage. Validity was assessed using specified criteria and the results were reported.

The analysis was appropriate and the authors assessed differences between the studies. The authors highlighted that only 2 studies explicitly stated that all patients admitted to the intensive care unit requiring mechanical ventilation were included to the trial, which may limit generalisability. Despite some lack of reported detail, the results presented appear to support the authors’ conclusions.

**Implications of the review for practice and research**

Practice: The authors did not state any implications for practice.

Research: The authors suggested that ease of use and reduced nursing time with CES may override cost concerns, but that studies comparing CES and OES may be of more relevance in developing countries, where issues of cost and space or bed allocation may of more importance.

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