Open and closed endotracheal suction systems in mechanically ventilated intensive care patients: a meta-analysis

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CRD summary
This study, which compared the clinical and cost-effectiveness of open and closed suction systems in adult intensive care unit patients, concluded that there is no evidence to suggest that one suction system is more effective than the other. Given the limitations of the included studies and the review, the reliability of the authors' conclusions is unclear and further research is required.

Authors' objectives
To compare the clinical and cost-effectiveness of open and closed endotracheal suction systems in adult intensive care unit (ICU) patients.

Searching
PUBMED, CINAHL, EMBASE and the Cochrane Library were searched to May 2006; the search terms were reported. In addition, retrieved articles were handsearched. Publications were restricted by language, but details were not specified.

Study selection
Studies in mechanically ventilated ICU adult patients were eligible for inclusion. The included studies involved neurosurgical, trauma, surgical (including acute lung injury), medical and cardiopulmonary patients.

Studies comparing open suction systems (OSS) with closed suction systems (CSS) were eligible for inclusion. The included studies reported a variety of doses, durations and endotracheal suction techniques, including preoxygenation, hyperoxygenation, clinical indication and saline use.

Studies measuring infection and survival, cardiorespiratory variables, or bacterial contamination as the primary outcome were eligible for inclusion. The included studies reported on infection and survival (ICU mortality, ventilator-associated pneumonia, and ICU length of stay), cardiorespiratory variables (mean arterial pressure, heart rate, arterial oxygen saturation (SaO2), partial arterial oxygen pressure PaO2) and mixed venous oxygen saturation, and bacterial contamination (colonisation of respiratory tract or tube, secretion removal and crossover contamination between bronchial system and gastric juices).

Studies were eligible for inclusion if they were randomised controlled trials (RCTs).

Two reviewers independently screened abstracts of papers for relevance.

Assessment of study quality
Two reviewers assessed validity according to adequacy of allocation concealment, with any discrepancies resolved through discussion.

Data extraction
Dichotomous data were converted into relative risks (RRs) with 95% confidence intervals (CIs). Continuous data using similar scales were converted into a weighted mean difference (WMD), while continuous data using different scales were converted into a standardised mean difference (SMD), with 95% CIs.

The authors did not state how the data were extracted for the review, or how many reviewers performed the data extraction.

Methods of synthesis
The RRs were pooled using a random-effects model, where appropriate. Continuous variables were pooled using the WMD or SMD, and sensitivity analyses were carried out on studies with similar criteria for measuring outcomes. Statistical heterogeneity was assessed using the $I^2$ test, and the authors reported using a funnel plot to assess publication bias.

**Results of the review**

Fifteen RCTs ($n=1,436$) were included in the review, five of which were crossover studies. Sample sizes ranged from 9 to 457 participants. Validity criteria for allocation concealment were unclear for 4 studies; the quality of the remaining 11 studies was inadequate.

**Infection and survival.**

The pooled RR for 8 studies assessing the effect of suction type on incidence of ventilator-associated pneumonia was 0.96 (95% CI: 0.76, 1.21, $p=0.72$), suggesting that there is little difference in incidence for the two suction systems. Sensitivity analyses did not alter the findings. There was no significant heterogeneity between the studies. Four studies found no differences in ICU mortality between the two suction systems ($p=0.81$). One study reported shorter length of ICU stay with OSS.

**Cardiorespiratory variables.**

Three studies assessing changes in mean arterial pressure reported significantly higher levels after OSS (SMD -0.43, 95% CI: -0.87, 0.00, $p=0.05$), thus favouring CSS. There was no significant heterogeneity between these studies. The pooled WMD for 4 studies assessing changes in heart rate also favoured CSS (WMD -6.33 beats per minute, 95% CI: -10.80, -1.87, $p=0.005$), and one study favoured CSS compared with OSS for mixed venous oxygen saturation (74% and 67%, respectively. There was significant heterogeneity between studies assessing $Sao_2$ and $Pao_2$ and pooling of the results was not possible.

**Bacterial contamination and secretion volume.**

The two studies comparing bacterial colonisation of the endotracheal tubes reported less frequent colonisation with OSS (RR 1.51, 95% CI: 1.12, 2.04, $p=0.008$). One study assessing bacterial contamination after endotracheal suction reported colonisation in five of 12 patients receiving OSS and none of 12 patients receiving CSS. Pooling of results for secretions removed was not possible, owing to significant heterogeneity.

The authors reported that the funnel plot analysis could not rule out publication bias.

**Cost information**

The costs per day were between £1.41 and £8.35 for OSS, and between £1.64 and £18.54 for CSS.

**Authors’ conclusions**

There is no evidence to suggest that CSS are more effective than OSS.

**CRD commentary**

The review question was clear and was supported by appropriate inclusion criteria for the participants, interventions, outcomes and study design. Relevant literature searches were undertaken using electronic databases and other appropriate sources. However, language restrictions on publications might have introduced language bias. Together with the fact that there was no apparent search for unpublished material, it is possible that relevant papers were missed, and publication bias was indicated. The reporting of the validity assessment was unclear. The data extraction was not described, thus the potential for reviewer error and bias cannot be ruled out. Appropriate methods were used to analyse the results and investigate statistical heterogeneity. However, there were a number of methodological limitations and quality issues with the included studies, and sample sizes were small. Given the limitations mentioned, the reliability of the authors’ conclusions is unclear and further research is required.

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

Practice: The authors stated that although differences were found for mean arterial pressure and heart rate, the actual
difference was minimal and may, therefore, be of little clinical relevance.

Research: The authors stated that randomised trials should be undertaken to assess the effectiveness of CSS in reducing cross contamination. Further analysis is needed to compare the true costs and benefits of both systems.

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