Effect of ventilator circuit changes on ventilator-associated pneumonia: a systematic review and meta-analysis

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CRD summary
This review concluded that frequent ventilator circuit changes were associated with high risk of ventilator-associated pneumonia and no routine circuit change was safe and justified. These conclusions were based on a sensitivity analysis (not pre-specified and excluded the largest study); all other meta-analyses showed non-significant results. The conclusions do not adequately reflect the data and should not be considered reliable.

Authors' objectives
To determine the effect of ventilator circuit changes on the risk of ventilator-associated pneumonia.

Searching
MEDLINE, EMBASE and SCOPUS were searched from January 1991 to June 2009. Key words were reported. Bibliographies of review articles, guidelines and original articles were screened for additional studies. Only studies published in full in English were included.

Study selection
Randomised controlled trials (RCTs) or sequential studies that compared clearly defined circuit change interventions with circuit change intervals of at least two days in mechanically ventilated adult patients were eligible for inclusion. Included studies had to report development of ventilator-associated pneumonia as an outcome measure.

Most of the included studies were conducted in intensive care unit settings. All studies except one used clinical criteria to diagnose ventilator-associated pneumonia; the other study used invasive lower respiratory tract sampling and culture to confirm diagnosis. Where reported, studies used unheated or heated-wire disposable circuits and wick, bubble or heat and moisture exchange humidifiers. Circuit change intervals studies ranged from two to 30 days. Most included studies were conducted in USA.

The authors did not state how many reviewers performed the study selection.

Assessment of study quality
The authors did not state that they assessed study validity.

Data extraction
Data on the number of ventilator-associated pneumonia events per intervention group were extracted as ventilator-associated pneumonia events/patients and ventilator-associated pneumonia events/1,000 ventilator days. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for ventilator-associated pneumonia events with less frequent versus more frequent circuit changes.

Two reviewers independently extracted data. Disagreements and uncertainties were resolved by discussion or contact with the authors.

Methods of synthesis
Pooled odds ratios and 95% CIs were estimated using a DerSimonian-Laird random-effects model.

Subgroup analyses were conducted for studies that compared circuit changes every two days with those that changed every seven days and for circuit changes at regular intervals versus no routine changes.

Between-study heterogeneity was assessed using the $X^2$ test (significant heterogeneity was defined as $p<0.10$) and the $I^2$ statistic.
Results of the review
Ten studies (n=19,169), four RCTs and six sequential studies, were included in the review. Nine studies were included in the meta-analyses.

The pooled odds ratio (based on five sequential studies) for ventilator-associated pneumonia with circuit changes every two days compared to every seven days was 1.501 (95% CI 0.952 to 2.365), which indicated no significant effect of circuit change frequency. When the largest study was excluded from the analysis (not pre-specified), a significant effect in favour of seven day circuit change was obtained. Significant heterogeneity was present in the initial analysis; this was eliminated on exclusion of the large study.

Three RCTs compared circuit changes every two or seven days with no routine changes and found no significant effect on ventilator-associated pneumonia. There was no evidence of significant between-study heterogeneity.

There was a trend to reduced risk of ventilator-associated pneumonia as circuit change intervals were extended, based on data from individual studies.

Cost information
Estimated yearly cost savings from fewer frequent circuit changes ranged from US dollars $4,900 (subacute facility) to $111,530 (hospital intensive care unit).

Authors’ conclusions
Frequent ventilator circuit changes were associated with a high risk of ventilator-associated pneumonia.

CRD commentary
The review had a clearly stated research objective and defined inclusion criteria. A number of sources were searched for relevant studies. The restriction to published English-language studies raised the possibility of language and publication biases. The data extraction process included measures to minimise error and/or bias; it was unclear whether similar measures were applied throughout the review process. No assessment of the methodological quality of included studies was reported and so the reliability of the results of individual studies could not be assessed. The meta-analysis upon which the authors appeared to base their conclusions was a sensitivity analysis (not pre-specified) that excluded the largest study in the group; only the sensitivity analysis and not the original analysis was reported in the study abstract.

Overall, the authors’ conclusions do not adequately reflect the data presented and should not be considered reliable.

Implications of the review for practice and research
Practice: The authors stated that no routine circuit change was safe and justified. They further stated that hospital infection-control policies and practice should reflect this.

Research: The authors did not state any recommendations for future research.

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