Continuous positive airway pressure for treatment of respiratory complications after abdominal surgery: a systematic review and meta-analysis


CRD summary
This review evaluated continuous positive airway pressure to prevent postoperative pulmonary complications after abdominal surgery. The authors concluded that continuous positive airway pressure can successfully reduce the risk of postoperative pulmonary complications, atelectasis and pneumonia. Despite some variation within the included studies, this was a largely well-conducted review and the conclusion is likely to be reliable.

Authors' objectives
To evaluate continuous positive airway pressure to prevent postoperative pulmonary complications after major abdominal surgery.

Searching
MEDLINE, EMBASE and CINAHL were searched from 1966 to 2005. The Cochrane Central Register of Controlled Trials was also searched. Searches were for studies in any language. Search terms were reported. Abstracts were excluded.

Study selection
Randomised controlled trials (RCTs) that compared standard therapy (physiotherapy and oxygen) plus early continuous positive airway pressure against standard therapy alone in patients aged over 18 years following abdominal surgery were eligible for inclusion in the review. Studies were excluded if patients required an emergency procedure (defined in the paper) or abdominal aortic aneurysm surgery. Also excluded were studies with patients who underwent abdominal surgery within a group receiving other surgical procedures and/or they had other pathologies.

The outcomes of interest were postoperative pulmonary complications with at least one of the following parameters: new cough and sputum production; abnormal breath sounds compared with baseline; temperature above 38°C; chest radiograph confirmation of atelectasis or new infiltrate; and physician confirmation of atelectasis or pneumonia. Pneumonia and atelectasis (each defined in the paper) were identified and differentiated where possible. Intubation and mortality rates (each defined in the paper) were also analysed.

The included studies spanned a period of 30 years. A variety of methods were used to deliver continuous positive airway pressure. The mean age of included patients ranged from 48 to 73 years. Lung disease was present in 0 to 29.5 per cent of patients. Two authors independently reviewed the studies for inclusion. Disagreements were resolved by consensus.

Assessment of study quality
Study quality was scored on randomisation, allocation concealment, blinding, patient selection, comparability of groups at baseline, treatment protocol, analysis of confounders, description of control of co-intervention, outcome definition, follow-up and intention to treat analysis. Possible scores ranged from 0 to 11. The authors did not state how many reviewers performed the quality assessment, or how disagreements were resolved.

Data extraction
Numbers of patients with the outcomes of interest were extracted in order to calculate risk reductions, along with 95% confidence intervals (CI). The number needed to treat to benefit was calculated. Attempts were made to contact authors for additional data, where necessary. Two authors independently extracted data for the review. Disagreements were resolved by consensus.

Methods of synthesis
Studies were pooled in a random-effects meta-analysis and weighted using the inverse of the variance method.
Heterogeneity was explored using the $I^2$ statistic. Publication bias was assessed in a funnel plot, in weighted regression and by Egger's test. Sensitivity analyses were performed by excluding dominant studies, by testing the influence of missing data for the development of postoperative pulmonary complications and by applying a fixed-effect model to the analysis.

**Results of the review**

Nine RCTs ($n=654$) were included in the meta-analysis: all trials were randomised; three reported allocation concealment; none were blinded. Co-interventions were reported in four trials. Intention to treat analysis was used in two trials. Outcome assessment criteria were implemented in eight trials. And eight trials showed comparability of groups at baseline. Follow up of more than seven days was reported in two trials.

In the pooled analysis of nine trials ($n=654$), the addition of continuous positive airway pressure produced a statistically significant lower rate of postoperative pulmonary complications than standard treatment alone: risk reduction $0.34$ (95% CI: $0.15, 0.48$); the number needed to treat to benefit was $14.2$ (95% CI: $9.9, 32.4$). Significance remained when one highly weighted study was excluded, and when the potential bias of missing intention to treat analysis data in another study was explored. Heterogeneity was low ($I^2 = 14\%$). Publication bias was indicated in the funnel plot, but was not confirmed by Egger's test.

In the pooled analysis of five trials ($n=175$), the addition of continuous positive airway pressure to standard therapy produced a statistically significant lower rate of atelectasis: risk reduction $0.25$ (95% CI: $0.03, 0.42$); the number needed to treat to benefit was $7.3$ (95% CI: $4.4, 64.5$). Significance remained when one one highly weighted study was excluded.

The pooled analysis of four trials ($n=506$) showed that the addition of continuous positive airway pressure to standard therapy produced a statistically significant lower rate of pneumonia: risk reduction $0.67$ (95% CI: $0.25, 0.86$); the number needed to treat to benefit was $18.3$ (95% CI: $14.4, 48.8$). Heterogeneity in both analyses was reported to be negligible, although this was based on a small number of studies. Publication bias was noted in the analysis of atelectasis ($p=0.003$).

A beneficial effect was reported for postoperative continuous positive airway pressure on intubation rate (risk reduction $0.85$, 95% CI: $0.34, 0.97$; two trials, $n=413$). The effect on mortality rate was not possible to determine due to the small number of events.

Fixed-effect analyses produced comparable results to the random-effects analyses.

**Authors' conclusions**

Continuous positive airway pressure reduced the risk of postoperative pulmonary complications, atelectasis and pneumonia in patients undergoing abdominal surgery.

**CRD commentary**

This review addressed a clear question and was supported by detailed inclusion criteria that were potentially reproducible. Relevant sources were included to identify studies for inclusion in the review and attempts were made to minimise language bias. However, there was no apparent search for unpublished material and publication bias was detected in parts of the final analysis. The validity assessment used appropriate criteria, although it was not clear if methods designed to reduce reviewer bias and error were employed. Such methods were used for other elements of the review process. Study details were provided in good detail. The chosen method of synthesis, and the exploration of heterogeneity and publication bias, added methodological rigour to the review. The authors acknowledged limitations in terms of variation within the included studies. Their conclusion accurately reflected the evidence presented, and is likely to be reliable.

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

**Practice:** The authors stated that continuous positive airway pressure was supported for use in clinical practice for reducing the risk of postoperative pulmonary complications, atelectasis, and pneumonia after abdominal surgery.

**Research:** The authors stated that further research was needed to evaluate the efficacy of continuous positive airway pressure.
pressure on mortality in patients with severe hypoxemia after abdominal surgery.

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