Influence of laminar airflow on prosthetic joint infections: a systematic review

Gastmeier P, Breier AC, Brandt C

CRD summary
The review concluded there was a significantly higher risk of severe surgical site infections following both hip and knee prosthesis for laminar airflow versus conventional ventilation and questioned whether laminar airflow was appropriate. The reliability of the author's conclusions is unclear since, although study sizes were high, there were study limitations and they recommended confirmation of their results.

Authors' objectives
To determine the effectiveness of laminar airflow in decreasing severe surgical site infections following hip and knee prosthesis.

Searching
PubMed was searched from 2000 to September 2011 for studies published in any language; search terms were reported. Bibliographies of relevant articles were searched.

Study selection
Cohort studies of hip and/or knee prosthesis procedures that provided data for severe surgical site infections (the primary outcome) and details of hospital operating theatre ventilation systems were eligible for inclusion. There were no secondary outcomes.

The cohort studies included consecutive prospective cohort studies of a German national surveillance system, a retrospective cohort study of a national arthroplasty registry in New Zealand, a retrospective American cohort using health insurance data and a small UK consecutive patient cohort. One study was of knee prosthesis and another of hip prosthesis and the remaining studies were of both hip and knee prosthesis. Laminar airflow was compared to conventional ventilation, non-laminar flow theatres or high-efficiency particulate air filtration (HEPA) turbulent air. Definitions of severe surgical site infections were reported for each study. Follow-up ranged from 90 days to one year.

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

Assessment of study quality
There was no formal assessment of study quality.

Data extraction
Two independent reviewers performed data extraction using a structured form. Data was checked for accuracy and differences resolved by a third reviewer. Authors were contacted for missing data. Dichotomous data for severe surgical site infection were used to calculate relative risks (RR) with 95% confidence intervals (CI). One study provided separate analyses for hip arthrosis and hip fracture patients.

Methods of synthesis
Results were pooled to give weighted relative risks with 95% CIs (Mantel-Haenzel). Between-study heterogeneity was assessed with X² and I² statistics. Initially forest plots were produced using a fixed-effects model but where significant heterogeneity was present a random-effects model was used. Publication bias was assessed visually using funnel plots. Separate meta-analyses were performed for hip arthrosis and hip fracture patients. A sensitivity analysis excluded the smallest study.

Results of the review
Five cohort studies were identified (total procedures 196,819, range 435 to 88,311, with 75,064 knee procedures and 121,755 hip procedures). The number of hospitals in each cohort study ranged from one to 256. Two studies adjusted for confounders (age, sex, American Society of Anaesthesiologists Score, wound class and other factors).

There was a statistically significantly higher risk of severe surgical site infections following knee prosthesis for laminar
air flow versus conventional ventilation (RR 1.36, 99% CI 1.06 to 1.74; I²=0%; four studies; fixed-effect model); only one individual study had a significant effect. The funnel plot showed no evidence for publication bias for the knee prosthesis analysis. There was a significantly higher risk of severe surgical site infections following hip prosthesis for laminar air flow versus conventional ventilation (RR 1.71, 99% CI 1.21 to 2.41; I²=64%; four studies; random-effects model); three individual studies had a significant effect.

A sensitivity analysis that removed the smallest study from the hip prosthesis analysis also found a significantly higher risk of severe surgical site infections for laminar air flow versus conventional ventilation (RR 1.71, 99% CI 1.45 to 2.01; I²=25%; three studies; random-effects model) but with much reduced heterogeneity.

**Authors’ conclusions**
Significantly higher risks of severe surgical site infections were found for laminar air flow versus conventional ventilation following both hip and knee prosthesis. It was questionable whether laminar air flow in existing operating rooms should be replaced by conventional ventilation systems.

**CRD commentary**
The review addressed a well-defined question. Only one database was searched and the search did not include trials or unpublished studies so some relevant studies may have been missed. Publication bias was assessed but few studies were identified, which reduced the reliability of the results. No formal assessment of study quality was made and little relevant data was reported to enable the reader to assess quality. Efforts were made to reduce error and bias in data extraction but the authors did not report whether this applied to study selection.

The synthesis performed seemed appropriate but the authors were inconsistent when reporting meta-analysis results; they reported odds ratios in the abstract and relative risks in the text. The authors noted that the different studies had different definitions for severe surgical site infections. Two studies were performed in Germany, where it is normal practice for hospitals to use operating theatres with the highest level of ventilation technology for hip and knee replacements. The authors described other physical factors that could affect infection rates in operating theatres in combination with ventilation. There were few studies but the numbers of procedures investigated were very high. Only two of the five studies adjusted for confounding factors and there was no adjustment for other relevant physical factors present in the operating theatres.

The authors recommended that their results should be confirmed and therefore the reliability of their conclusions is unclear.

**Implications of the review for practice and research**
**Practice:** The authors considered it would be a waste of resources to install laminar air flow in new operating theatres and that laminar air flow systems in existing operating theatres should questionably be replaced with conventional ventilation systems but this needed to be confirmed by other studies.

**Research:** The authors considered that conducting randomised controlled trials (RCTs) for severe surgical site infections after joint replacement was unrealistic because of the low rates of severe surgical site infection. They considered that using surveillance and national registry data was advantageous over RCTs as it represented actual rather than ideal conditions. To confirm the results of this review, the national surveillance systems for severe surgical site infections after hip and knee replacements in other countries should perform similar analyses to this review.

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**Bibliographic details**

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Record Status
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.