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Laminar airflow and the prevention of surgical site infection. More harm than good?

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ARTICLE INFO

Article history:
Received 28 June 2014
Received in revised form
24 September 2014
Accepted 12 October 2014
Available online xxx

Keywords:
Laminar airflow
Surgical infection
SSI
Theatre ventilation

ABSTRACT

Introduction: Laminar airflow (LAF) systems are thought to minimise contamination of the surgical field with airborne microbes and thus to contribute to reducing surgical site infections (SSI). However recent publications have questioned whether LAF ventilation confers any significant benefit and may indeed be harmful.

Methods: A detailed literature review was undertaken through www.Pubmed.com and Google scholar (http://scholar.google.com). Search terms used included "laminar flow". "laminar airflow", "surgical site infection prevention", "theatre ventilation" and "operating room ventilation", "orthopaedic theatre" and "ultra-clean ventilation". Peer-reviewed publications in the English language over the last 50 years were included, up to and including March 2014.

Results: Laminar airflow systems are predominantly used in clean prosthetic implant surgery. Several studies have demonstrated decreased air bacterial contamination with LAF using bacterial sedimentation plates placed in key areas of the operating room. However, apart from the initial Medical Research Council study, there are few clinical studies demonstrating a convincing correlation between decreased SSI rates and LAF. Moreover, recent analyses suggest increased post-operative SSI rates.

Conclusion: It is premature to dispense with LAF as a measure to improve air quality in operating rooms where prosthetic joint surgery is being carried out. However, new multicentre trials to assess this or the use of national prospective surveillance systems to explore other variables that might explain these findings such as poor operating room discipline are needed, to resolve this important surgical issue.

Introduction

Surgical site infection (SSI) results in significant morbidity in patients undergoing surgery. Patients who develop SSI are up to 60% more likely to spend time in an intensive care unit and have a readmission rate five times higher than those without SSI.[1] Combined with increased length of inpatient stay, SSI leads to increased overall care costs.[1–6]

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http://dx.doi.org/10.1016/j.surge.2014.10.003
1479-666X/

Please cite this article in press as: McHugh SM, et al., Laminar airflow and the prevention of surgical site infection. More harm than good?, The Surgeon (2014), http://dx.doi.org/10.1016/j.surge.2014.10.003

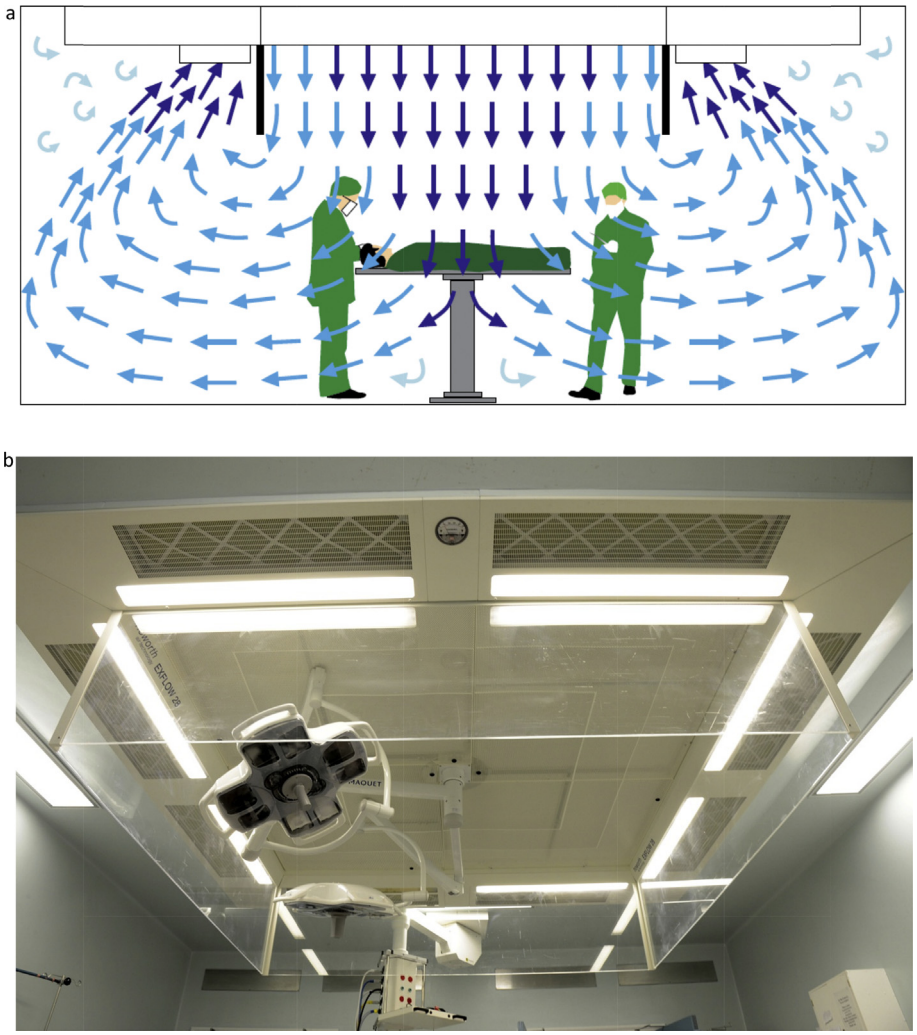

Fig. 1 – Schematic outline of airflow from laminar airflow unit (a) and example of ceiling canopy providing such ventilation (b).

The significance of airborne bacteria remains controversial in terms of its contribution to increased SSIs as these infections are multi-factorial in origin. The normal skin flora of patients or healthcare workers causes more than half all infections following clean surgery.[7] A recent study in the Journal of the American College of Surgeons noted a trend towards decreased operating room staff turnover in hospitals with low SSI rates.[8] This suggest the importance of expertise and continuity in minimising SSI but it has also been considered best practice for many decades to try to ensure good air quality in operating rooms.

Two types of air ventilation dynamics are commonly use in operating rooms to decrease airborne bacteria; the laminar airflow (LAF) system and the conventional turbulent system.[9] In operating rooms where conventional airflow is used, conditioned air is supplied through diffusers installed on the ceiling. The incoming air is mixed with air in the theatre thus diluting any contaminated air throughout the entire room volume. With LAF, low-turbulence downward displacement of air is delivered directly over the operating area through a combination of high airflow rates and high efficiency particulate air (HEPA) filtration, resulting in minimal air bacterial counts (Fig. 1). In theory this creates a protective curtain of airflow around the patient.[9]

Standard operating room ventilation filters air with the removal of 80–97% of particles ≥5 microns.[7] Laminar airflow systems with HEPA filters remove 99.97% of particles ≥0.3 microns.[7] In addition, LAF creates a homogenous flow of air in the operating room with very little turbulence. However, LAF is expensive to install and maintain, has significant energy requirements and requires continuous technical maintenance.[10]

To date, the use of LAF is predominantly used in orthopaedic procedures during the insertion of prosthetic graft materials such as artificial joint replacement, to minimise contamination of the surgical field with airborne microbes.[11,12] More recent publications have questioned whether LAF ventilation confers any benefit and even suggests that post-operative SSI rates may be higher after surgery under LAF conditions compared to conventional operating rooms with turbulent ventilation.[13–15]

Through an extensive review of peer-reviewed literature we sought to determine whether LAF ventilation is an important factor in the prevention of SSI Table 1.

Please cite this article in press as: McHugh SM, et al., Laminar airflow and the prevention of surgical site infection. More harm than good?, The Surgeon (2014), http://dx.doi.org/10.1016/j.surge.2014.10.003