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Detection and surveillance of exogenous contamination in orthopaedic surgery

Akademisk avhandling

Som för avläggande av medicine doktorsexamen vid Sahlgrenska akademin, Göteborgs universitet kommer att offentligen försvaras i R-aulan, R-huset Mölndals sjukhus, Länsmansgatan 28, Mölndal, den 24 oktober, klockan 9.00

av Frans Stålfelt

Fakultetsopponent:

Professor Emeritus Olle Svensson

Umeå Universitet, Umeå, Sverige

Avhandlingen baseras på följande delarbeten

I. Stålfelt F, Svensson Malchau K, Björn C, Mohaddes M, Erichsen Andersson A. Can particle counting replace conventional surveillance for airborne bacterial contamination assessments? A systematic review using narrative synthesis. *American Journal of Infection Control, 2023;51(12):1417–1424.*

II. Stålfelt F, Caous J, Svensson Malchau K, Björn C, Mohaddes M. Evaluation of real-time biofluorescent particle counters for monitoring airborne contamination in orthopaedic implant surgery compared to conventional air sampling. *Antimicrobial Stewardship & Healthcare Epidemiology, 2025;5(1): e93.*

III. Stålfelt F, Tenghamn J, Malchau H, Svensson Malchau, K. Deployment of real-time particle detection monitoring system in operating rooms for airborne contamination assessments, a methodological evaluation. *Bone Jt Open 2025;6(4): 499–505.*

IV. Stålfelt F, Caous J, Malchau H, Svensson Malchau K. Impact of intraoperative routines and behaviours on particle contamination and surgical site infections in orthopaedic surgery. *Submitted.*

SAHLGRENSKA AKADEMIN
INSTITUTIONEN FÖR KLINISKA VETENSKAPER

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Detection and surveillance of exogenous contamination in orthopaedic surgery

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Abstract

Surgical site infection (SSI) after orthopaedic implant surgery is a serious complication that may result in patient morbidity, prolonged rehabilitation and increased mortality. SSIs also impose considerable economic burden on the healthcare system, as extended resources are needed for these patients. To reduce the risk of SSI, more effective infection prevention strategies are needed. The papers compiled in this thesis contribute to that effort by assessing how airborne bacterial contamination, also referred to as exogenous contamination, affects SSI outcomes in the operating room (OR), by identifying and analysing risk scenarios for particle emissions during surgeries.

Conventional methods for measuring exogenous contamination consist of collecting bacterial air samples in the OR, expressed as colony forming units (CFU). Conventional methods are, however, time and resource demanding. The objective of Paper I was to evaluate previously published research investigating the correlation between real-time particle counting and CFU conducted by conventional active air sampling techniques. The paper was designed as a systematic review with narrative synthesis. The results from the reviewed articles were inconsistent and not fully comparable due to differences in applied methodologies. Paper I concludes that while particle counting may have the ability to offer fast and valuable insights on the overall level of exogenous contamination in the OR, more research is needed to further clarify the association between particle counts and CFU.

A more modern method to assess exogenous contamination is by utilizing biofluorescent particle counters (BFPCs), which can distinguish between biological and non-biological particles. The aim of Paper II was to analyse the correlation between CFU and biofluorescent particles sampling methods, and to assess the validity of using BFPC as a potential surrogate for exogenous risk assessments. The results demonstrated no significant correlation between the two methods, indicating that BFPC measurements should be interpreted with caution when evaluating the risk for SSI during surgeries. Further validation is needed for BFPCs to be used as a replacement for conventional exogenous risk assessments.

Paper III aimed to evaluate the effectiveness of a newly developed surveillance system for monitoring exogenous contamination in ORs. The paper investigated two scenarios believed to influence particle emission and influx: intraoperative team shift changes and the implementation of reusable surgical sheets. The results showed that team shift changes significantly increased the influx of particles, while reusable sheets were associated with reduced particle emissions compared to disposable options. Paper III concluded that there is great potential for the surveillance system to detect high-risk scenarios that may pose a risk for exogenous contamination in the OR.

Building on the surveillance system introduced in Paper III, Paper IV aimed to evaluate how OR staff behaviours influence the particle emission and influx in the OR, as well as the risk of SSIs caused by those behaviours. The study focused on three variables: the number of staff members present in the OR, the frequency of intraoperative door openings and the duration of the surgery. The results showed that a higher number of staff members present was associated with increased particle levels, however number of people present did not differ significantly between SSI and no-SSI cases. Furthermore, the results demonstrated that door openings occurred more frequently and surgeries were longer for those operations that resulted in SSIs. These findings underscore the importance of implementing a surveillance system which can provide feedback to the OR staff on intraoperative behaviours, as part of an effective infection prevention strategy.

Keywords: Surgical site infections, infection prevention, exogenous contamination

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