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Performance Assessment of Ventilation Systems for Operating Theatres

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Abstract : Introduction: Ventilation technology in operating theatres (OT)is internationally regulated by dif-ferent standards, which define basic specifications for technical equipment and many times also the necessary operating and performance parameters. This confronts the operators of healthcare facilities with the question of finding the best ventilation and air conditioning system for the OT in order to achieve the goal of a large and robust surgicalworkzone with appropriate air quality and climate for patient safety and occupational health. Additionally, energy consumption and the potential need for clothing that limits transmission of bacteria must be considered as well as the total life cycle cost. However, the evaluation methodology of ventilation systems regarding these matters are still a topic of discussion. To date, there are neither any uniform standardized specifications nor any common validation criteria established. Thus, this study aimed to review data in the literature and add ourown research results to compare and assess the performance of different ventilations systems regarding infection preventive effects, energy efficiency, and staff comfort. Methods: We have conducted a comprehensive literature review on OT ventilation-related topics to understand the strengths and limitations of different ventilation systems. Furthermore, data from experimental assessments on OT ventilation systems at the University of Amberg-Weidenin Germany were in-cluded to comparatively assess the performance of Laminar Airflow (LAF), Turbulent Mixing Air-flow(TMA), and Temperature-controlled Airflow (TcAF) with regards to patient and occupational safety as well as staff comfort including indoor climate.CFD simulations from the Royal Institute of Technology in Sweden (KTH) were also studied to visualize the differences between these three kinds of ventilation systems in terms of the size of the surgical workzone, resilience to obstacles in the airflow, and energy use. Results: A variety of ventilation concepts are in use in the OT today. Each has its advantages and disadvantages, and thus one may be better suited than another depend-ing on the built environment and clinical workflow. Moreover, the proper functioning of OT venti-lation is also affected by multiple external and internal interfering factors. Based on the available data TcAF and LAF seem to provide the greatest effects regarding infection control and minimizing airborne risks for surgical site infections without the need for very tight surgical clothing systems. Resilience to obstacles, staff comfort, and energy efficiency seem to be favourable with TcAF. Conclusion: Based on literature data in current publications and our studies at the Technical Uni-versity of Applied Sciences Amberg-Weidenand the Royal Institute of Technoclogy, LAF and TcAF are more suitable for minimizing the risk for surgical site infections leading to improved clin-ical outcomes. Nevertheless, regarding the best management of thermal loads, atmosphere, energy efficiency, and occupational safety, overall results and data suggest that TcAF systems could pro-vide the economically most efficient and clinically most effective solution under routine clinical conditions.

Keywords : ventilation systems, infection control, energy efficiency, operating theatre, airborne infection risks
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