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Innovative Ventilation Technology for Operating Rooms

Abstract: The purpose of this work was to evaluate the decontamination potential of the Potok system both in an experimental setting in a research Operating Room (OR) with standalone Air Decontamination Units (Potok 150-M-01) and in a clinical setting in a real operating theatre in Moscow. Our experiments showed an impact of the Potok units on the bacterial contamination of the room air according to the Swedish SIS-TS 39:2015 standard. For the initial measurements in our research OR in Weiden this could be shown by a decrease of the bacterial burden at all three different measurement points (OR table, instrumentation tray, periphery).

Also the subsequently done measurements in the Moscow hospital verified this decontaminating effectivity of the Potok system. In this case the initial background contamination of the operating theatre was higher than in the research OR in Germany. This bacterial burden could be effectively decreased by the use of the installed Potok based ventilation system.

Keywords: bacterial burden, decontamination, ventilation technology

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1 Introduction

In order to reduce intraoperative bacterial contamination as well as subsequent treatment costs, the use of ventilation systems in the operating room has become a hygienic standard. [2-4] The Russian company Potok has now developed an innovative concept for air decontamination which can be used flexibly for many different applications. In contrast to common ventilation systems, the Potok technology is not based on HEPA filtered air but is predicated on a physical method with constantly alternating electric fields for the treatment of supply air.

The aim is to assess the decontamination potential of the

Potok system [5] in an experimental setting in the research OP at the Ostbayerische Technische Hochschule Amberg-Weiden as well in a clinical setting at a Moscow hospital by using microbiological experiments according to the Swedish standard (SIS-TS 39: 2012 2015).

2 Material and Methods

The microbiological testing of the room air was realized with the active air sampler Impaktor FH6 from Markus Klotz GmbH. Three parallel samples were taken at the predefined measuring points. These were located directly on the operating table (1,2 m above the ground and $\leq 0,5$ m from the center of the table), on the instrument table and in the periphery of the room near an exhaust unit. The sampling was carried out by the impaction method, whereby an air volume of 1000 liters per 10 minutes is collected via an opening on a blood agar plate. The culture media was incubated for 3 days at $35^{\circ}\text{C} \pm 1^{\circ}\text{C}$. After the incubation the plates were photographed, the colonies were counted manually and documented as colony forming units per cubic meter of air (cfu / m³). Two units of the "Potok 150-M-01 Stand-alone Air Decontamination Unit (ADU)" were available for the evaluation of the effectiveness at the Ostbayerischen Technische Hochschule. The units were positioned in an experimental surgical arrangement according to the Swedish standard SIS-TS 39: 2015 (Fig.1).

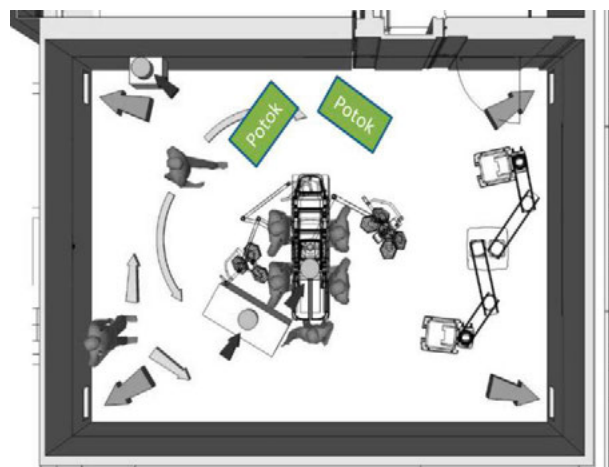


Figure 1: Positioning of the Potok Systems in the OR

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In order to compare the Potok technology with other established ventilation systems the measurements were subsequently repeated in a clinical situation. Therefore, the activity and efficiency of the Potok units in a real setting of an operating room in a hospital in Moscow was tested. The room was chosen because it has comparable size and features like the research operating room and has the Potok system installed as ventilation system.

3 Results

Our tests showed a significant impact of Potok 150-M-01 Standalone Air Decontamination Units (ADU) on the bacterial contamination of the room air. This could be shown for the measurements in the research operation at the Ostbayerische Technische Hochschule in Weiden by a decrease in the bacterial load at all three measuring points. It should also be briefly mentioned that the bacterial load on the operating table and the instrumentation table is below the threshold of the Swedish Standard SIS-TS 39: 2015 for Infectious Interventions of $\leq 5 \text{ cfu} / \text{m}^3$ (Fig. 2).

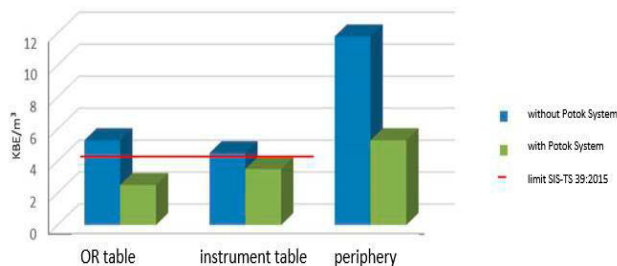


Figure 2: Comparison of microbiological contamination of room air (OR OTH-Weiden)

The subsequent measurements carried out in a Moscow hospital confirmed this room air decontaminating effect of the Potok technology. For the three different measurement locations our results showed a decrease of more than 87%. The initial bacterial burden of $37 \text{ cfu}/\text{m}^3$ on the OR table and $39 \text{ cfu}/\text{m}^3$ on the instrument board and the periphery of the room had been reduced to $\leq 5 \text{ cfu}/\text{m}^3$ in average for every measurement point (Fig. 3).

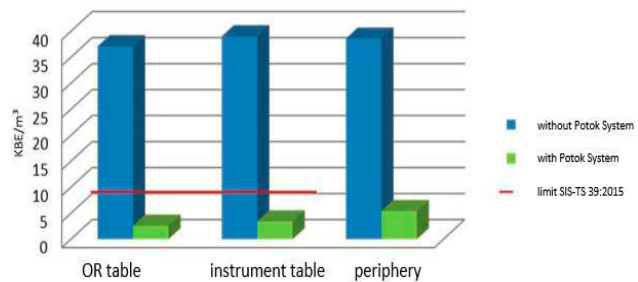


Figure 3: Comparison of microbiological contamination of room air (OR Moscow)

4 Discussion

Our results showed a significant effect of the Potok units on the bacterial load of the room air. In the experimental setting in the Research OP at the Ostbayerischen Technischen Hochschule Weiden this effect was rather small due to the minimal initial microbiological contamination of the room and the use of mobile units. However, a decrease of the microbiological load could be observed for every measuring point. This decontamination effect of the Potok technology was confirmed by the results of the measurements in the real environment of the operating room of a Russian hospital. The ventilation system with Potok units led to a large decrease in airborne microorganisms. On average the microbiological load for each measuring point could be reduced to $\leq 5 \text{ cfu} / \text{m}^3$. The Potok technology can be compared with existing ventilation systems (e.g. temperature-controlled ventilation system [TAF], low-turbulence displacement flow [TAV] or turbulent mixing ventilation [TML]) with similar technical requirements. A further advantage of the Potok units is the lack of HEPA filters. This represented a reduced operator maintenance due to the lack of regular filter changes. A remarkable point is also the energy-saving aspect of the technology. In our tested OP the total air exchange of the room was $3400 \text{ m}^3 / \text{h}$ in the Potok units. Based on our findings regarding the Potok system it should be discussed whether the technology could be considered as a viable alternative to other currently used ventilation systems and whether it represents another potential solution for infection control of airborne microbiological burden of operating theaters.

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