



Challenges connected to ventilation of operating rooms:

- A surgical procedure is complex and transient
- Large variations depending on the type of procedure
- Possibly varying requirements depending on the patients state of health
- The surgical staff may have different preferences for their thermal environment

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WHICH IS A BETTER SOLUTION FOR OPERATING ROOM VENTILATION – LAMINAR AIRFLOW OR MIXING VENTILATION?

Summary

At present, both mixing ventilation (MV) systems and laminar air flow (LAF) systems are used in operating rooms (ORs). The objective of this study was to compare the performance of laminar airflow systems and mixing ventilation in operation rooms at St. Olavs hospital. Field measurements of air velocity distribution and CFU level were conducted at St. Olavs hospital, Norway. This study provides evidence that the air velocity and CFU level above a lying patient in the OR with a LAF system and a MV show a wide range of values under real operating conditions.

Introduction

- The air quality of the operating microenvironment may be an important contributor to prevent surgical site infections (SSIs).
- Both mixing ventilation (MV) systems and laminar air flow (LAF) systems have been used to tentatively reduce the CFU (Colony Forming Unit) density in ORs.
- The OR contains numerous transient phenomena that may cause significant changes to indoor air distribution patterns.

Objective

The objective of this study was to compare the performance of laminar airflow systems and mixing ventilation in operation rooms.

Method

Measurements of CFU and experimental measurements of airflow distribution were performed in different orthopedic operating rooms equipped with either LAF or MV systems at St. Olavs hospital.

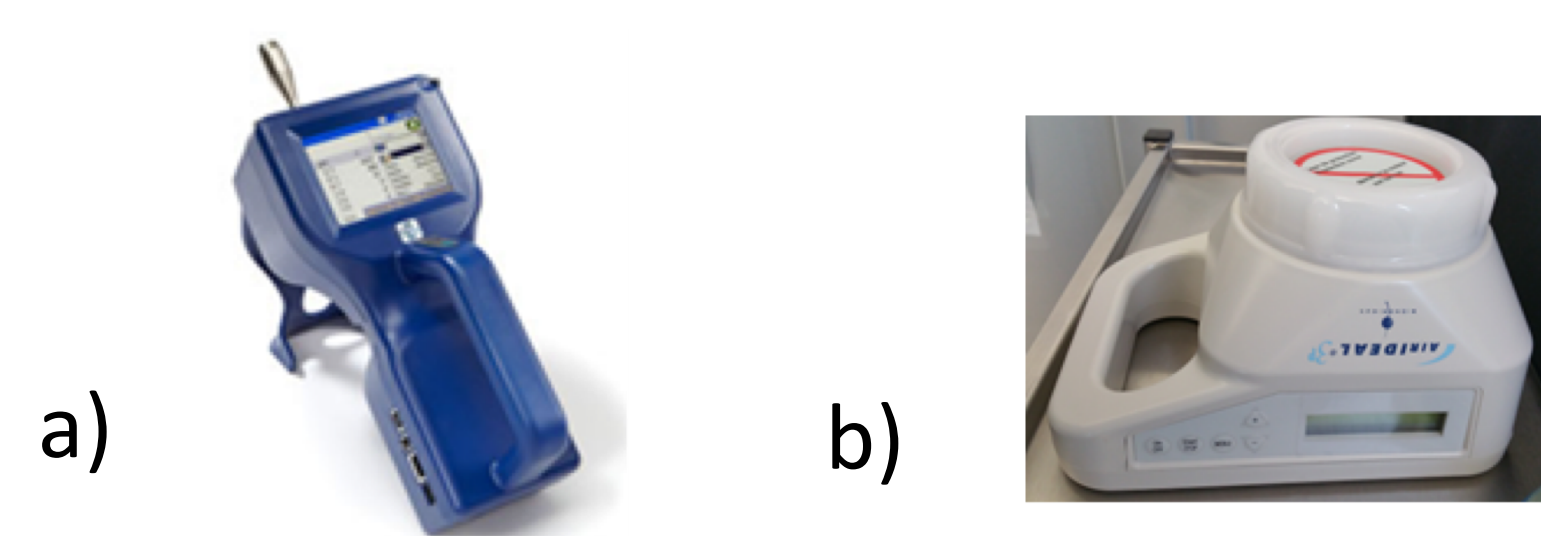


Figure 1: Measurement instruments: a) AEROTRAK™ Handheld Particle Counter Model 9306, b) AirIdeal CFU measurement device (BioMérieux)

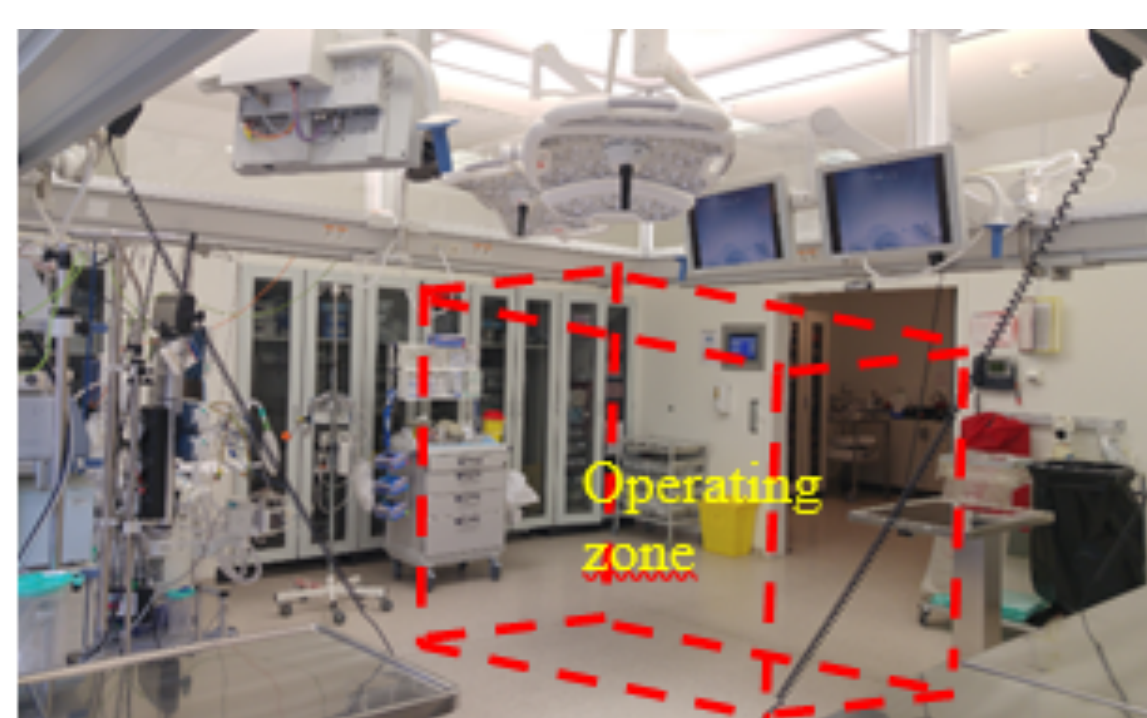


Figure 2: The OR with laminar airflow system at St. Olavs hospital (Cao et. Al 2017)



Figure 3: The locations of the measurement instruments for CFU and particle measurement

Measurement results

Measurements of CFU levels in the OR with MV

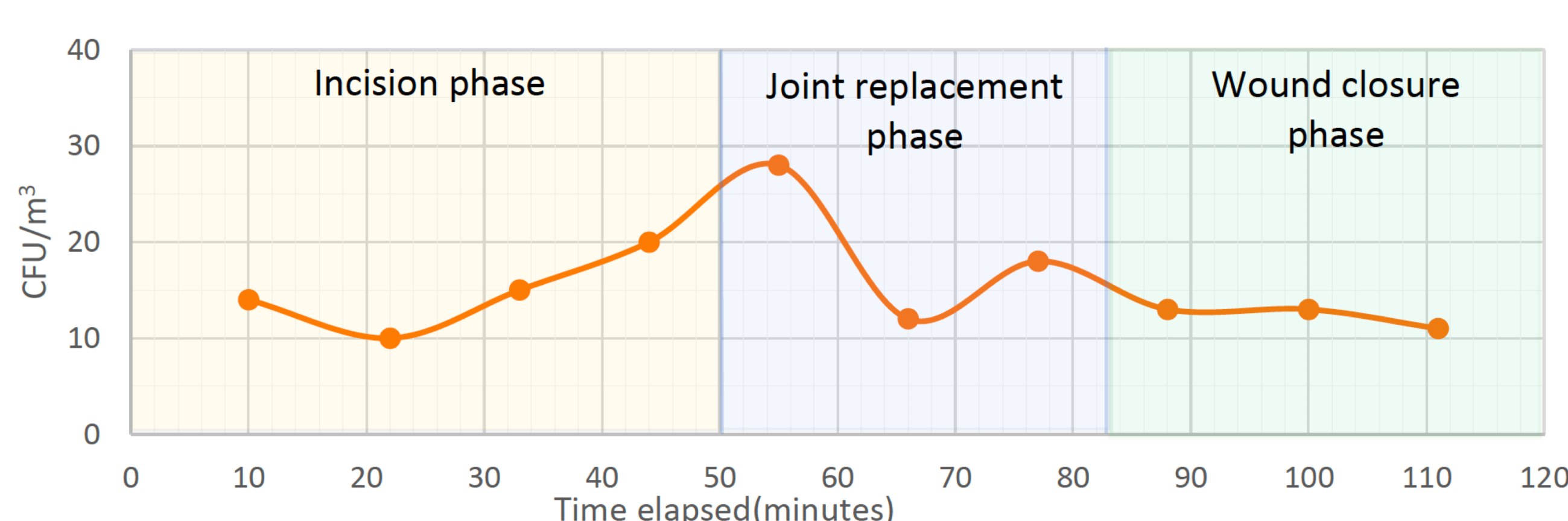


Figure 4 CFU/m³ values measured in the OR with MV. The x-axis shows time points during mock surgery at which the samples were taken. Y-axis shows CFU count. Colours indicate the three phases of the mock surgery: Incision phase (0-50 min), Joint replacement phase (50-83 min) and Wound closure phase (83-120 min). (Christoffer, 2019)

Measurement results

Measurements of CFU levels in the OR with LAV

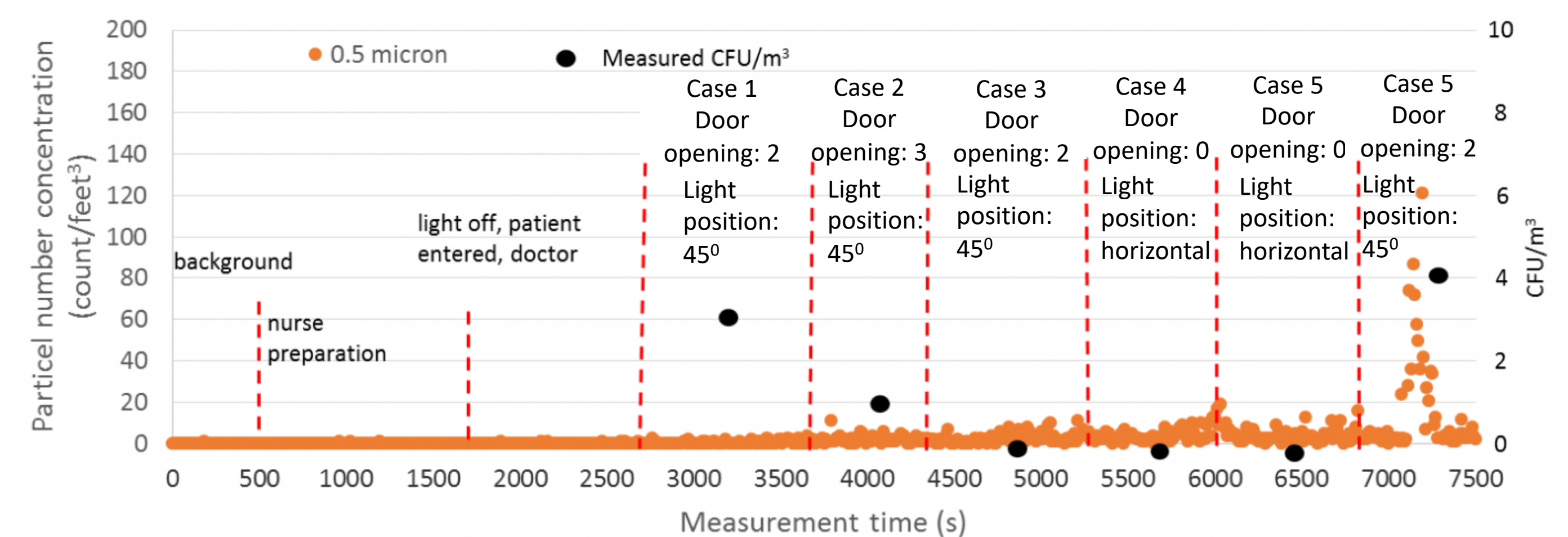


Figure 5: The measured fine particle concentration (0.5-1.0 micron) and CFU/m³ in the operating room with LAF. CFU levels varies in these 6 cases from 0 to 4, which meets the requirement of ultra clean conditions in OR. The variation of particle concentration indicates the disturbance of surgical staff activities. (Cao et al. 2017)

Measurements of airflow distribution in ORs with LAV and MV

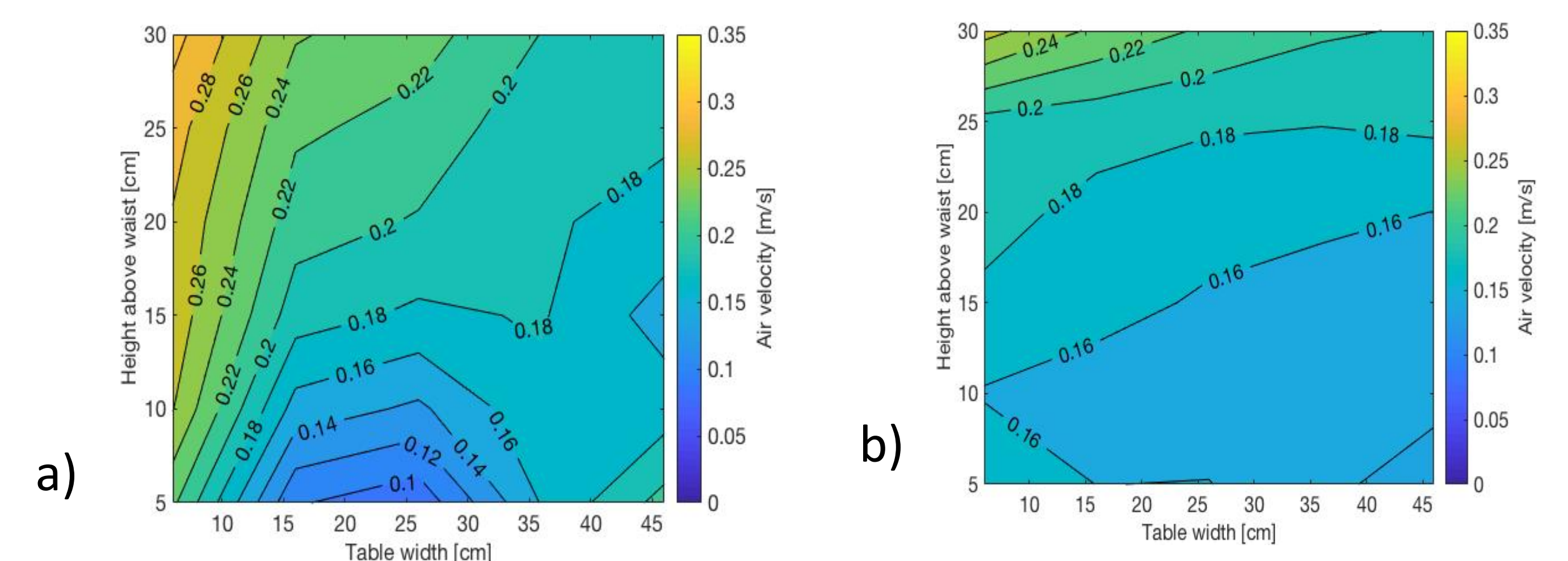


Figure 6: Velocity contours above a lying patient surrounded by three surgical staff: a) above the waist position with an LAF system; b) above the waist position with an MV system (Cao et al. 2019)

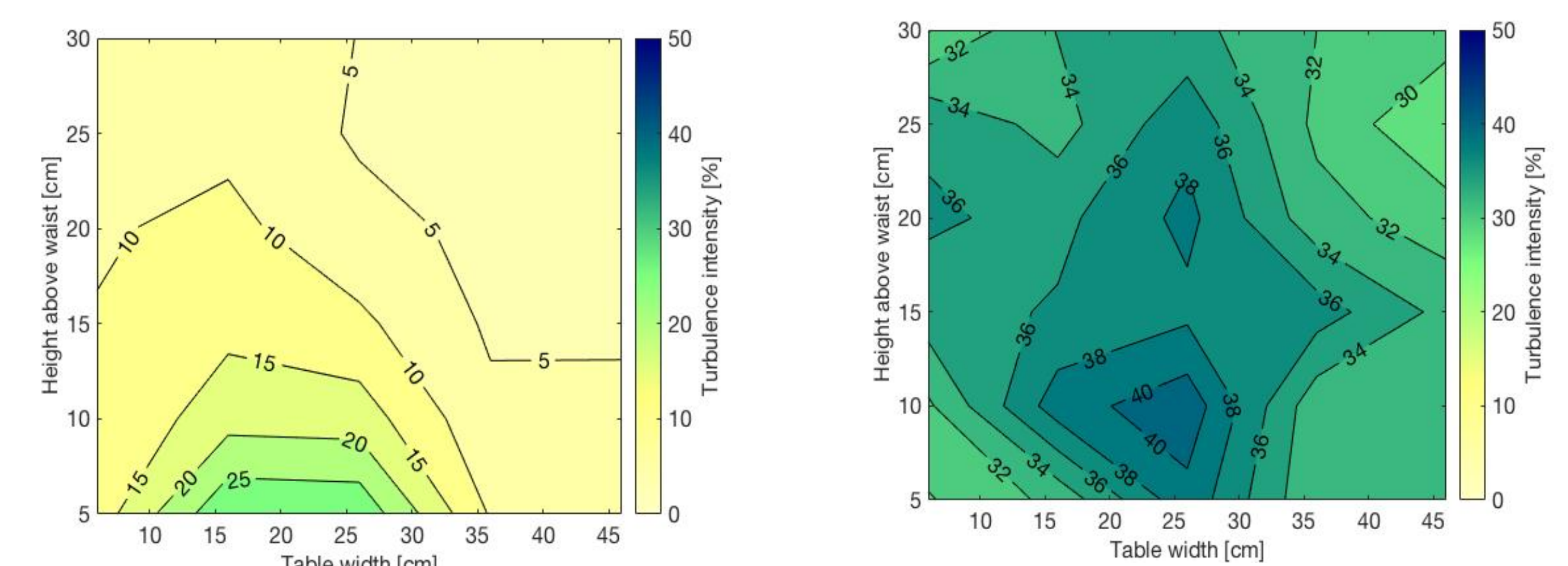


Figure 7: Turbulence intensity contours above a lying patient surrounded by three surgical staff: a) above the waist position with an LAF system; b) above the waist position with an MV system (Cao et al. 2019)

Conclusions

- This study showed a complex relationship between the local indoor air quality and airflow distribution in the operating microenvironment of a lying patient.
- Air distribution changed significantly under various conditions involving the presence of different heat sources, including surgical lamps, the patient, surgical staff and various monitors in the orthopedic OR.
- Under many operating conditions, the airflow distribution from the laminar airflow system was disrupted more than with mixing ventilation method.
- Lower CFU levels may be achieved in ORs with mixing ventilation when using proper surgical clothing with lower activity intensity.

References

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