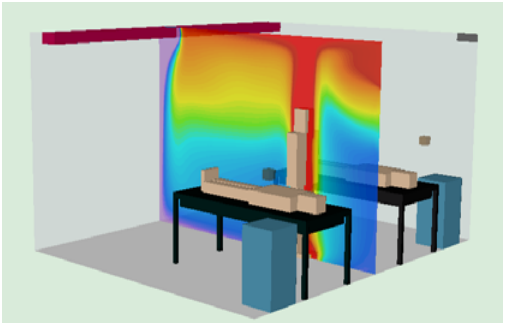
Cross Infection in Hospital Wards with Downward Ventilation

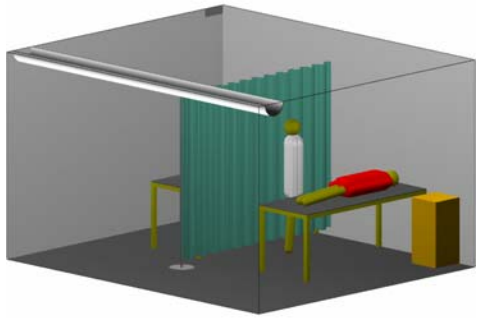
- Different Locations of Return Openings without and with Partitions between Beds

Peter V. Nielsen, Yuguo Li, Morten Buus and Frederik V. Winther

Downward Ventilation, Partitions and Different Locations of Return Openings

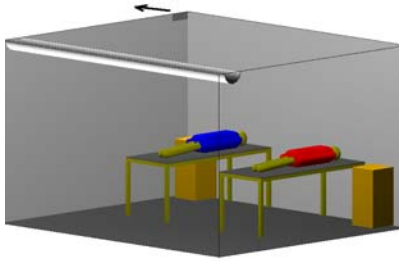
The air distribution system

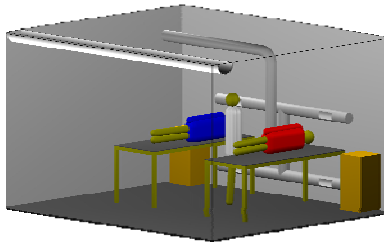


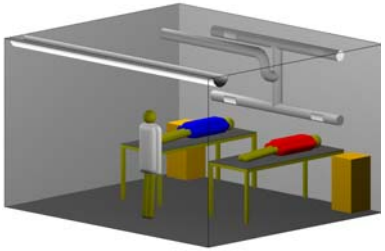


Partitions

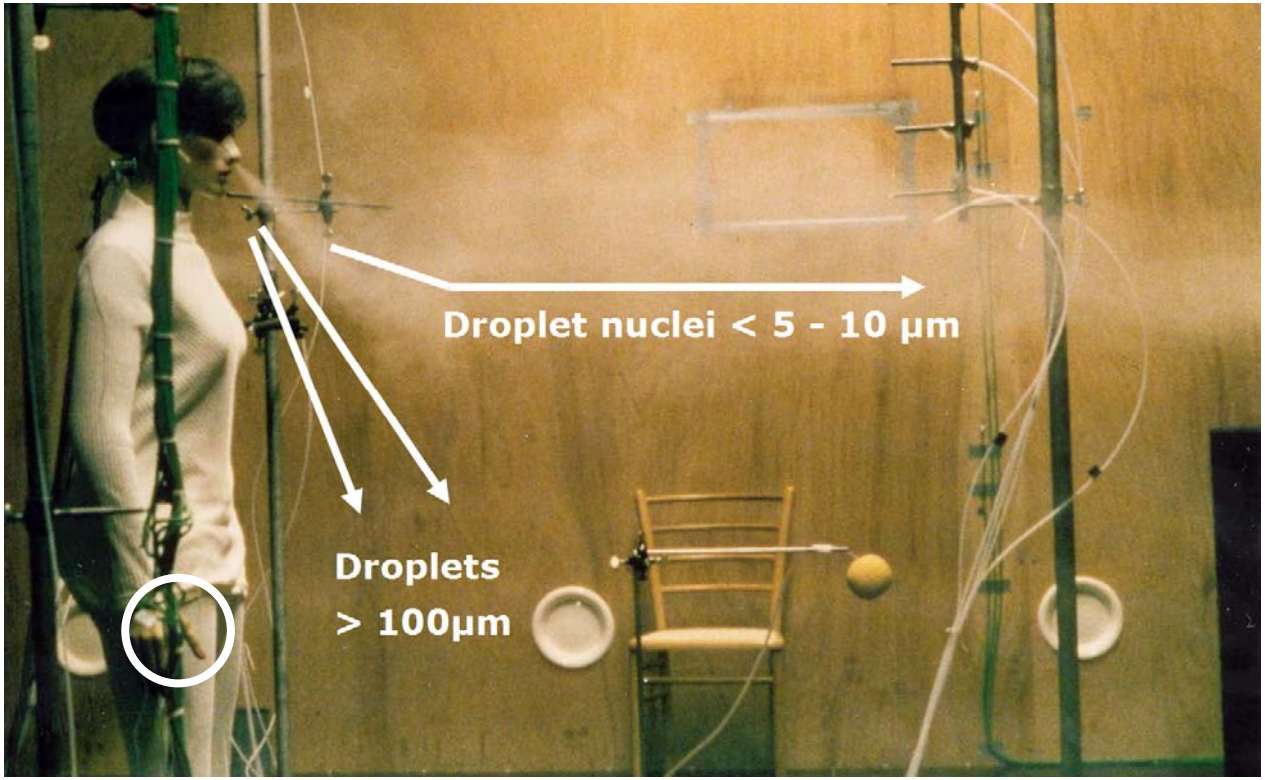
Different locations of return openings







Three Transmission Routes



Airborne transmission by aerosols, long range, more than 2-3 meters or even several 100 meters

Droplet-borne transmission by large droplets by close contact, short range, less than 2-3 meters

Contact transmission

Measurements of Cross Infection with Tracer Gas

Emission from a surface

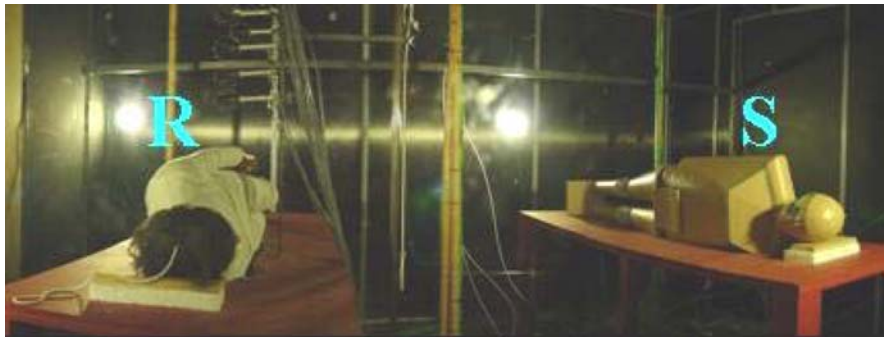
”Point” source

Emission from the body

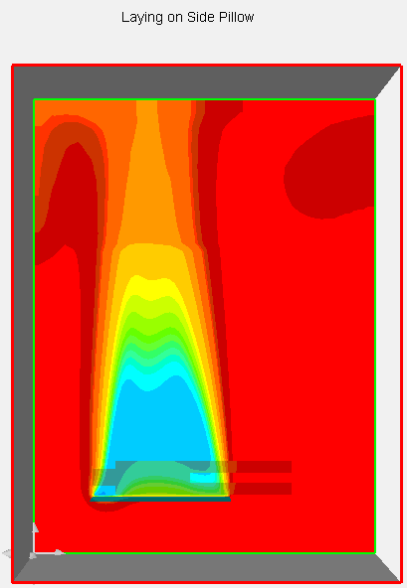
Exhalation

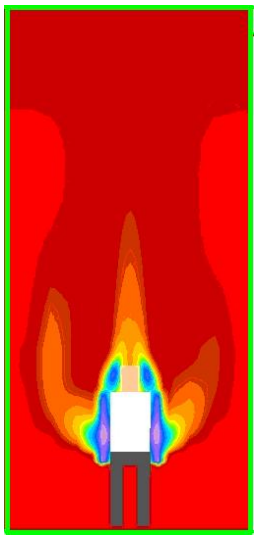
Exposure of a seated person

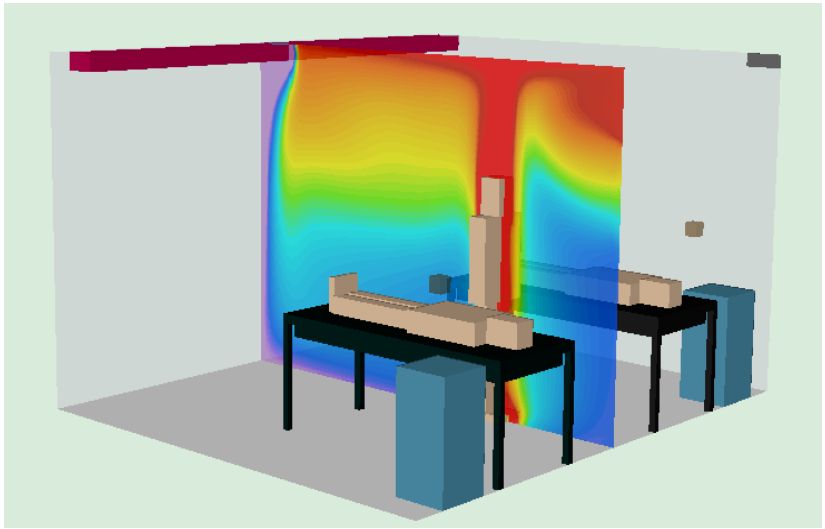
Exposure of a person in a bed

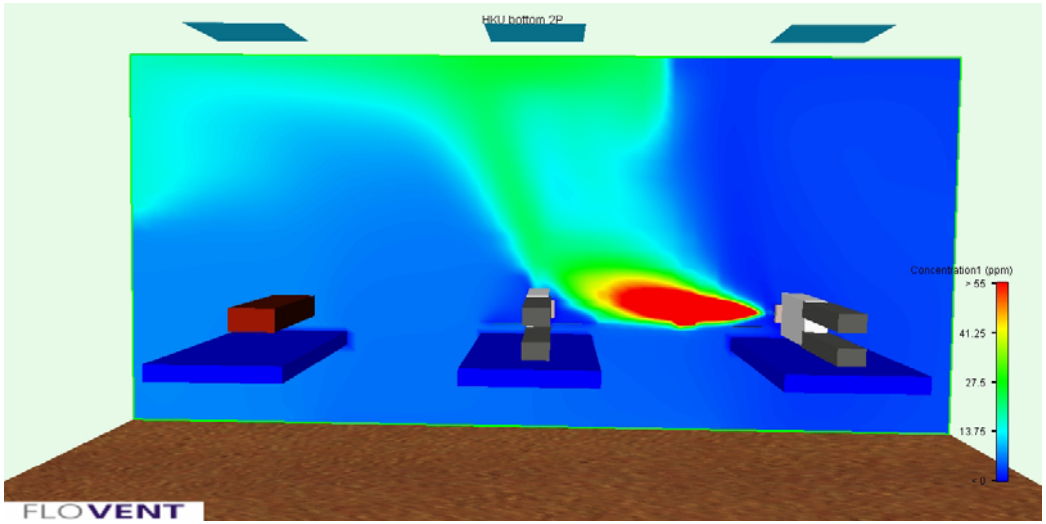


CFD Prediction of Cross Infection

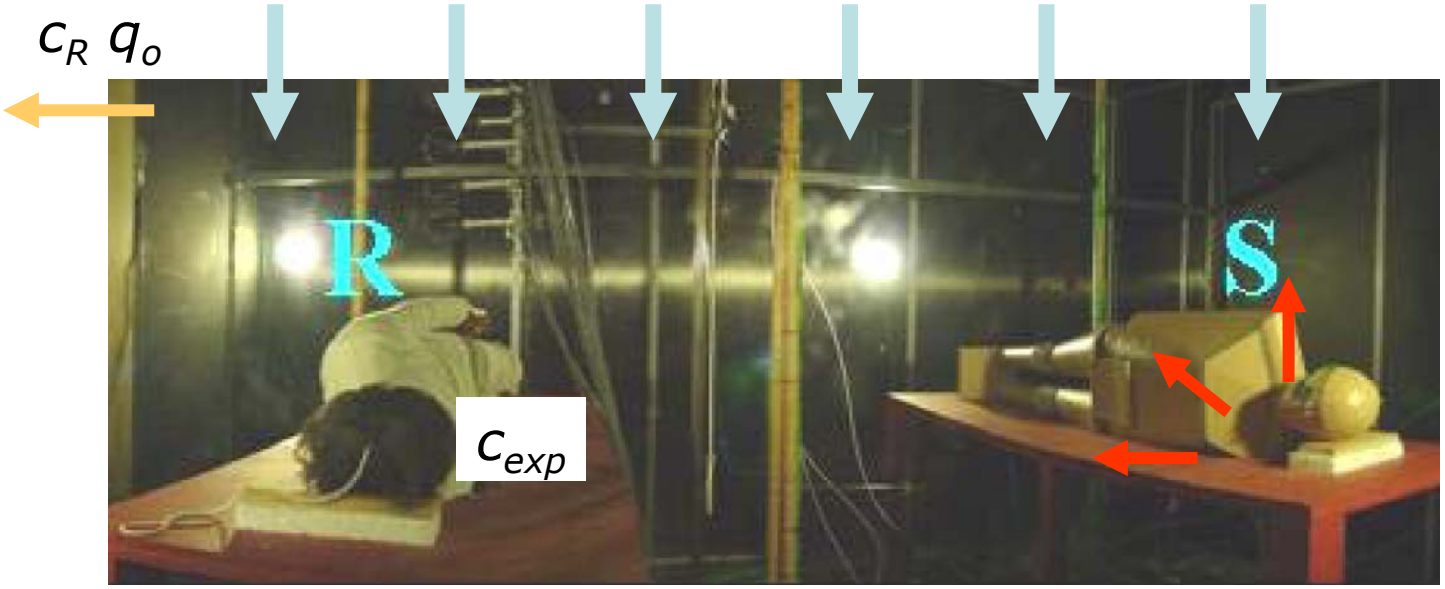








Protection against Airborne Infection - Exposure Level



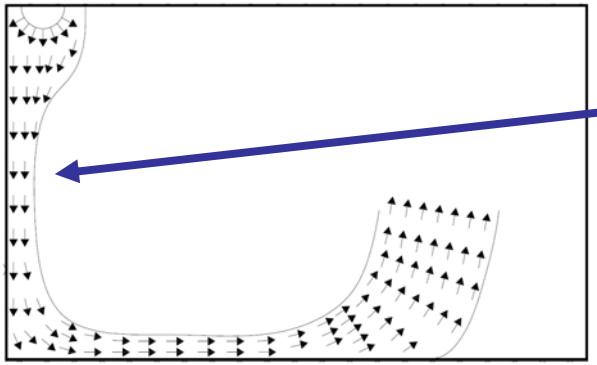
$$c_{exp} = (1/q_o) \cdot (1/\varepsilon) \cdot S$$

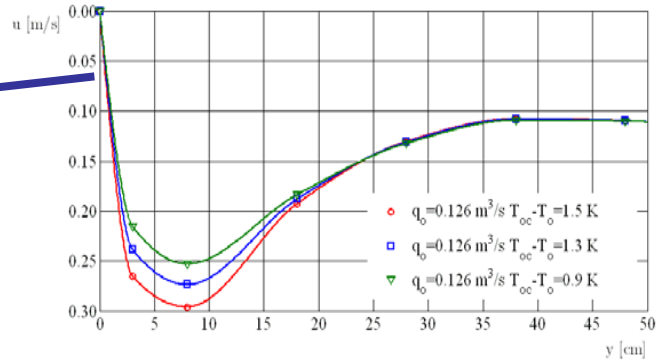
Low exposure

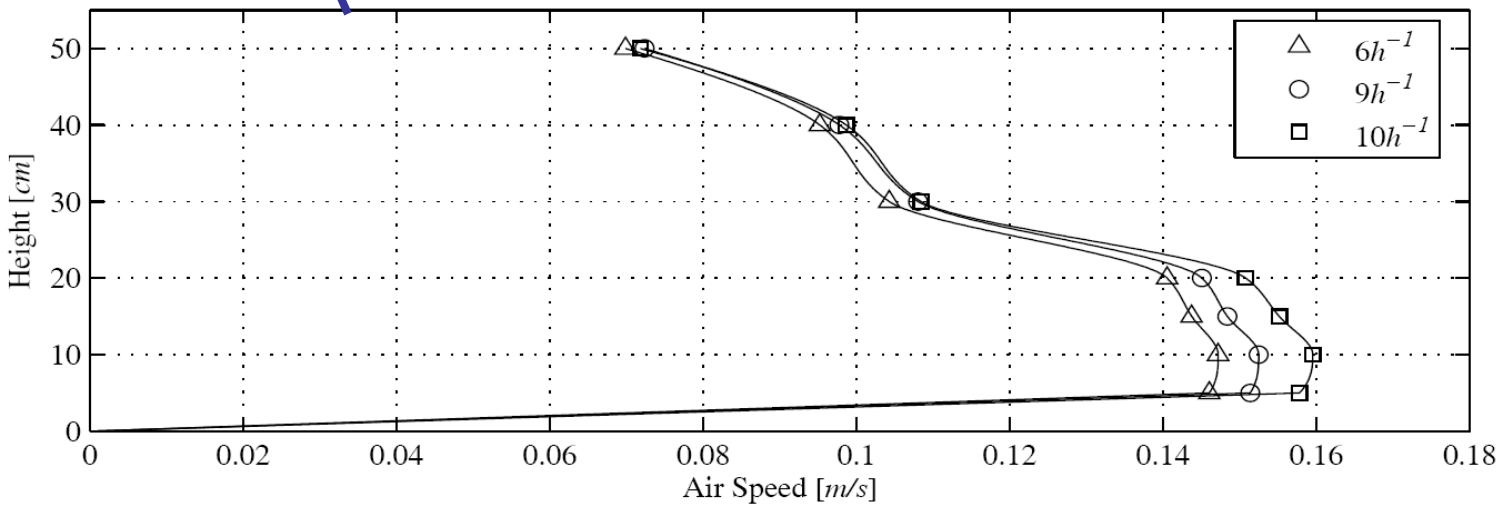
High flow rate

High air quality index

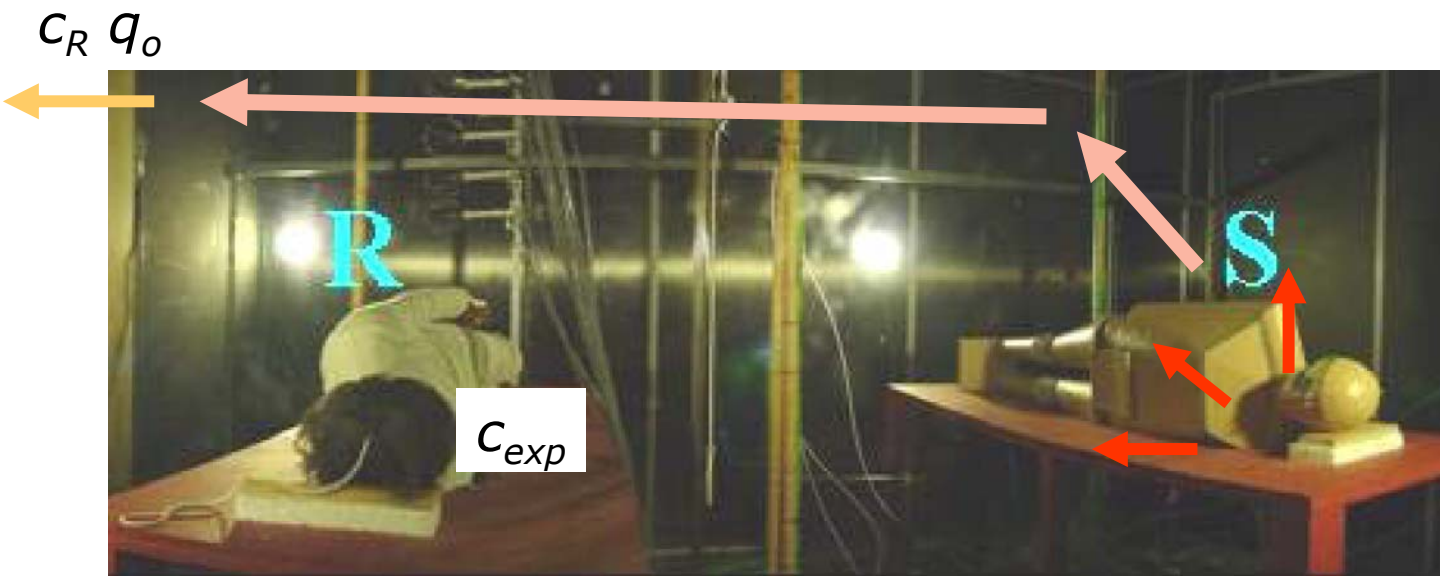
Draught in the Occupied Zone at High Flow Rates







Protection against Airborne Infection - Exposure Level



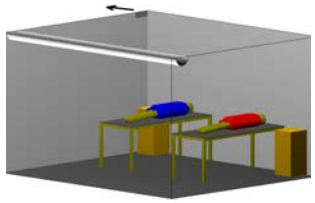
$$c_{exp}=(1/q_o)\cdot(1/\varepsilon)\cdot S$$

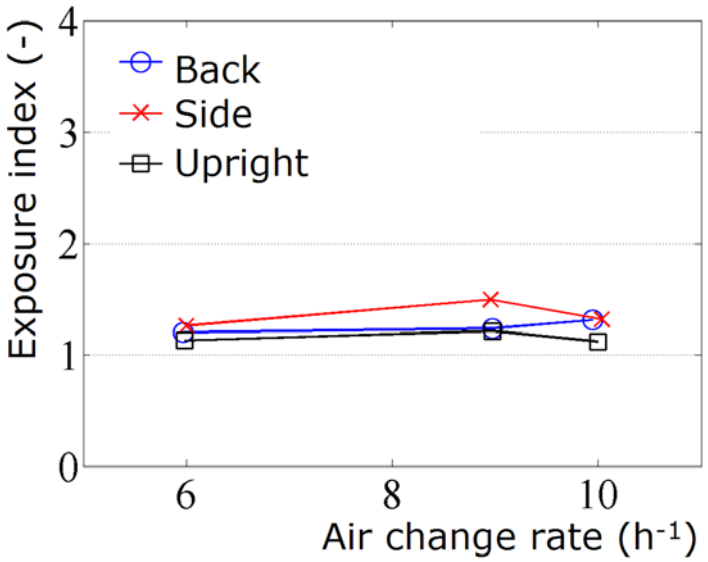
Low exposure

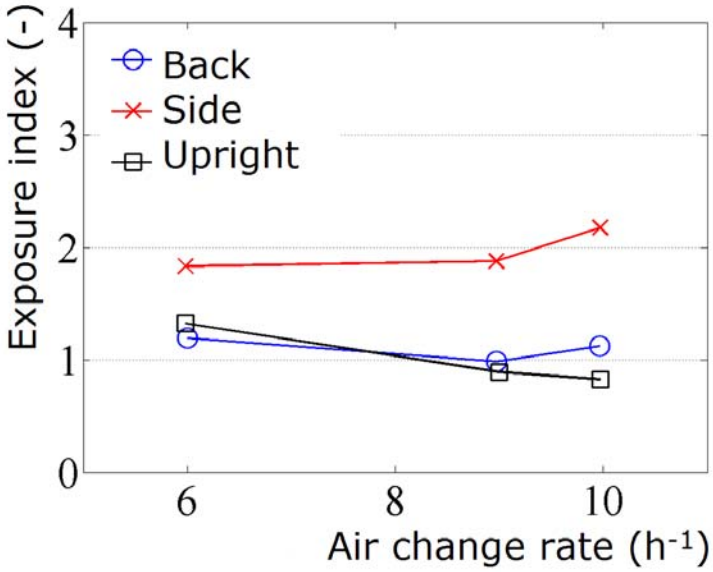
High flow rate

High air quality index

One Exhaust Opening







Both manikins are sitting,
lying on the back or on the side

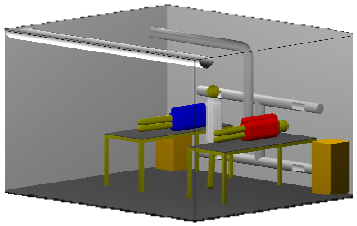
Textile partition does not change the personal exposure index

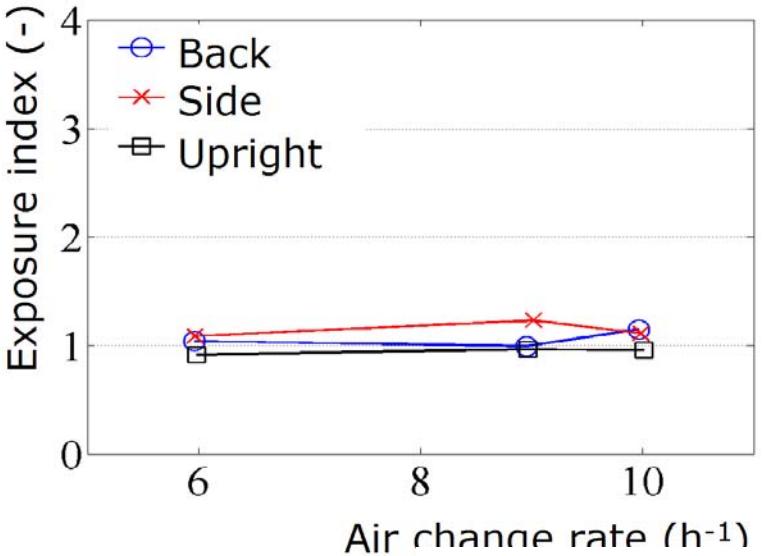
Target manikin is standing below the diffuser

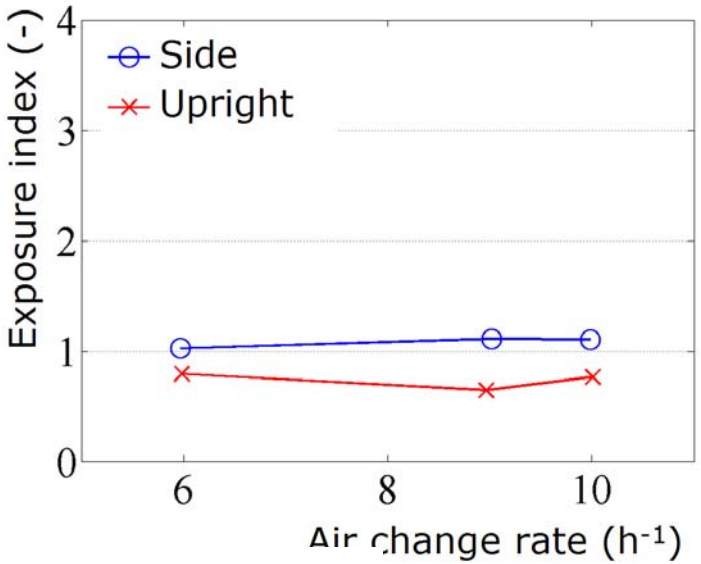
Textile partition does not change ε except when the healthcare worker is standing between beds close to sitting source

Low Location of Return Openings

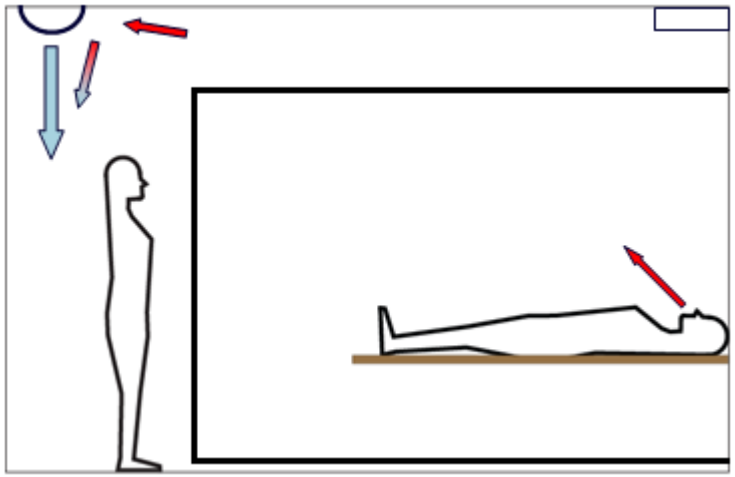
CDC and ASHRAE recommendation





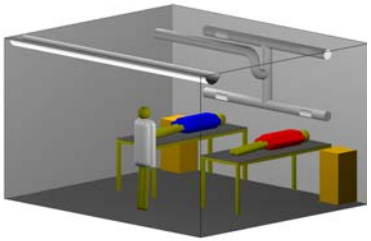


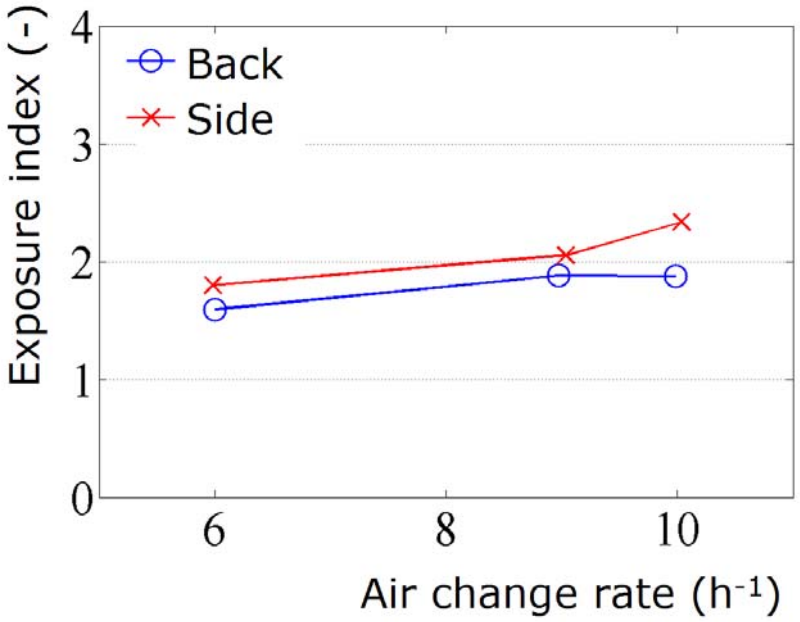
Both manikins a is standing below
lying on the bacl

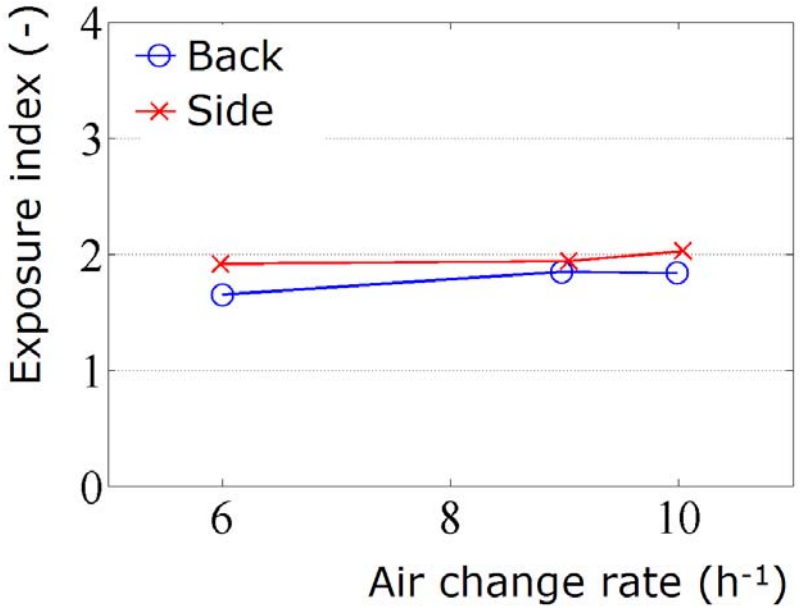


Experiments with assistant standing
by the source ma he exposure index
is 1.0 for the targ artition.
The index for the .0.

High Location of Return Openings







Both manikins are lying on the back or on the side

Target manikin is standing below the diffuser

High location of return openings doubles the exposure index, $\varepsilon \sim 2$

Conclusions

The risk of airborne infection can be minimised in hospital wards by using a high air change rate, and by obtaining a high personal exposure index.

A ceiling-mounted low velocity diffuser generates vertical ventilation and passive displacement flow in a room when it is used together with a high location of distributed return openings. The system can handle a high flow rate without causing discomfort. The system can generate a high personal exposure index.

Textile partitions do not decrease the risk of cross infection for the air distribution system considered here.

Thank you very much!