3D Airflow Simulations to Mitigate the Environmental Transmission Risk

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1. Modelisation of dispersion of bio-aerosols emitted by a patient

Computational Fluid Dynamics (CFD) simulations have been commonly used in both the transportation and aerospace industries for dozens of years to understand airflow and optimize new design. In the context of the COVID-19 pandemic, healthcare workers are facing airborne contamination with a lack of understanding of droplet propagation in indoor airflow. During the first and second waves in France, both hospital staff and engineers collaborated to use CFD to anticipate and mitigate the risk of airborne contamination in patient's rooms. Different studies were conducted to provide both understanding and guidance to three of the main aspects of aerosol risk. A first study in an Intensive Care Unit (ICU) in Bichat Hospital in Paris, France aimed to validate a simulation model of a coughing virtual mannequin against physical tests (Fig. 1). After a first validation phase on aerosol emissions, an optimization of the ICU room was performed using simulation in order to improve both aerosol extraction and deposit reduction.

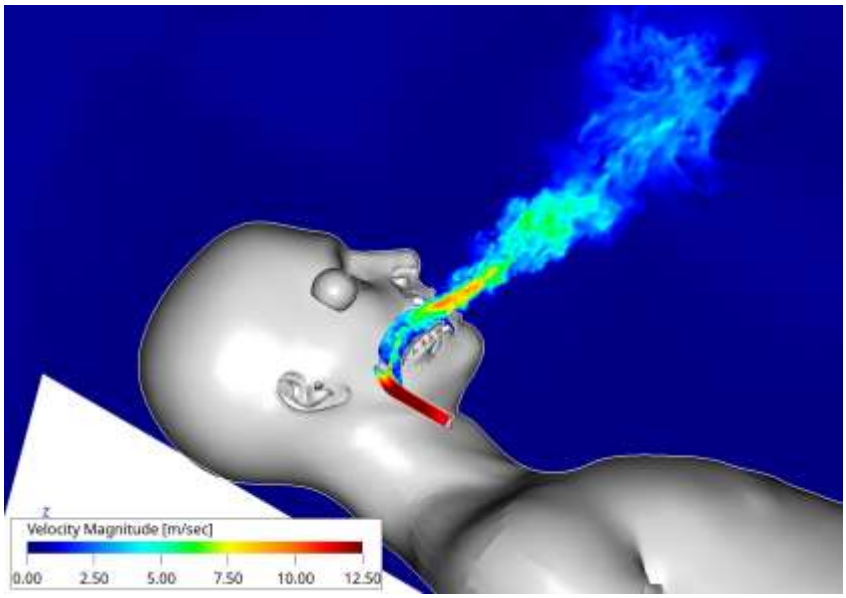

Figure 1 *Instantaneous air velocity during a cough*

2. Risk of cross contamination in a public space

During the second wave in France, medical activities not related to COVID patients were maintained. Post-surgery rooms were highly exposed to cross-contamination risk due to the proximity of COVID+ and COVID- patients in the same shared and open environment. To anticipate and mitigate this risk, both the medical team of La Pitié Salpétrière in Paris used 3D simulations to anticipate aerosols propagation, assess the benefit of dedicated location to COVID patients and find pragmatic and simple mitigation solutions (Fig. 2). By smartly changing ventilation system and the room layout, significant improvement can be provided.

Figure 2 *aerosols propagation in a post surgery room*

3. Influencing factors of surface contamination

On top of the aerosols propagation, the surface contamination risk is related to the combination of the internal layout of healthcare facilities and both environmental and ventilation impact. The ICU staff of the Avicenne Hospital in Bobigny compared both simulation predictions and Polymerase chain reaction (PCR) technology for qualitative detection of presence of SARS-Cov-2. Since the medical staff decided to keep the windows open during the first wave, simulations helped the healthcare workers to understand the impact of the wind direction and intensity on the surface contamination.

References

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