Innovations to fight respiratory diseases

What strategy for the ventilation of buildings during an epidemic period ?

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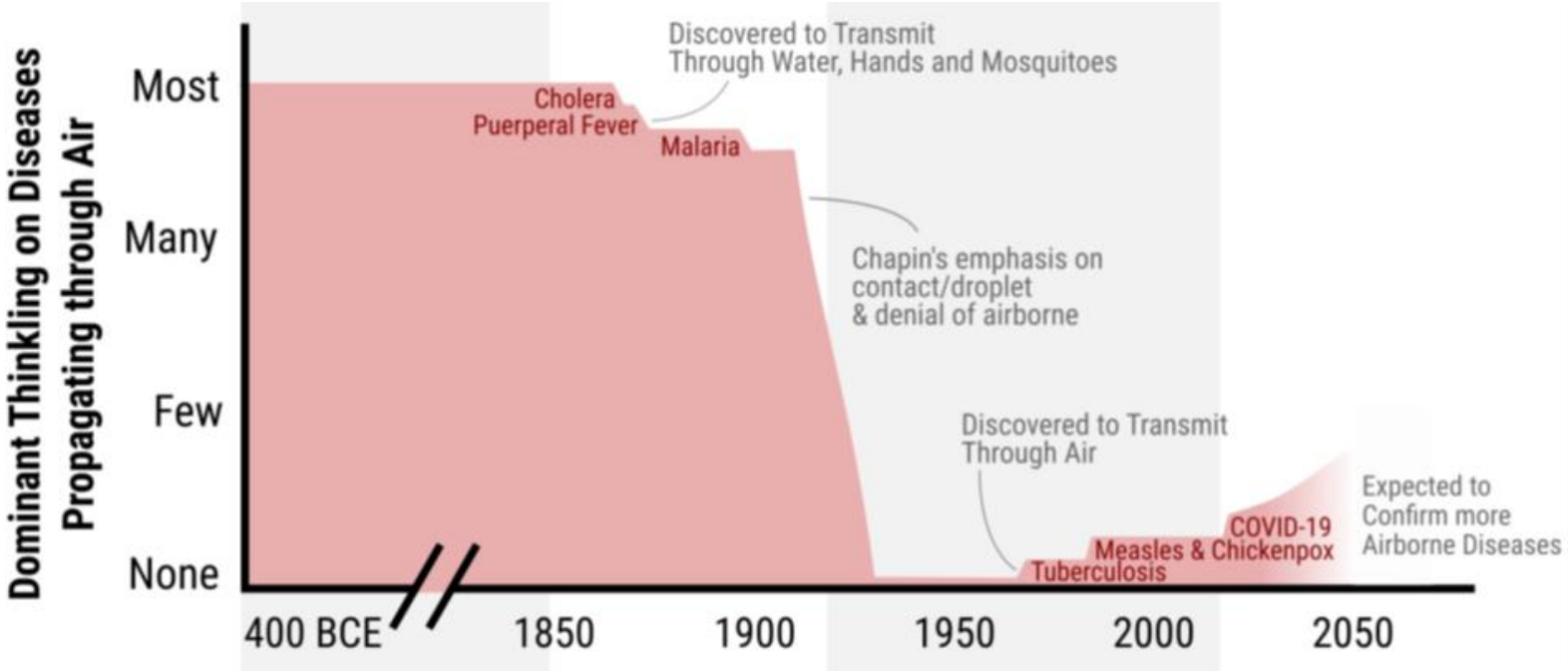
Airborne transmission is a major mode of transmission for many respiratory infectious deseases



MIASMA THEORY
400 BCE

PARADIGM SHIFT
1850

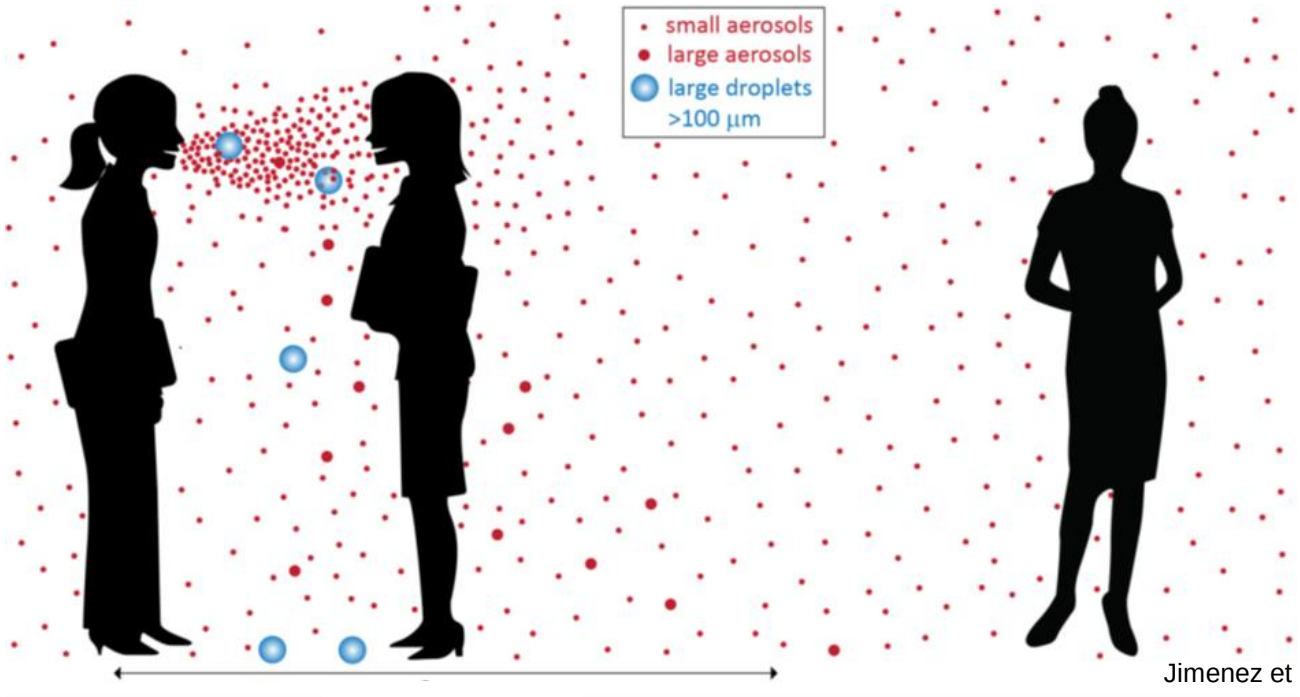
RESISTANCE TO AIRBORNE
1920

PARADIGM SHIFT
2020

Jimenez et al., 2021

What is exactly airborne transmission ?

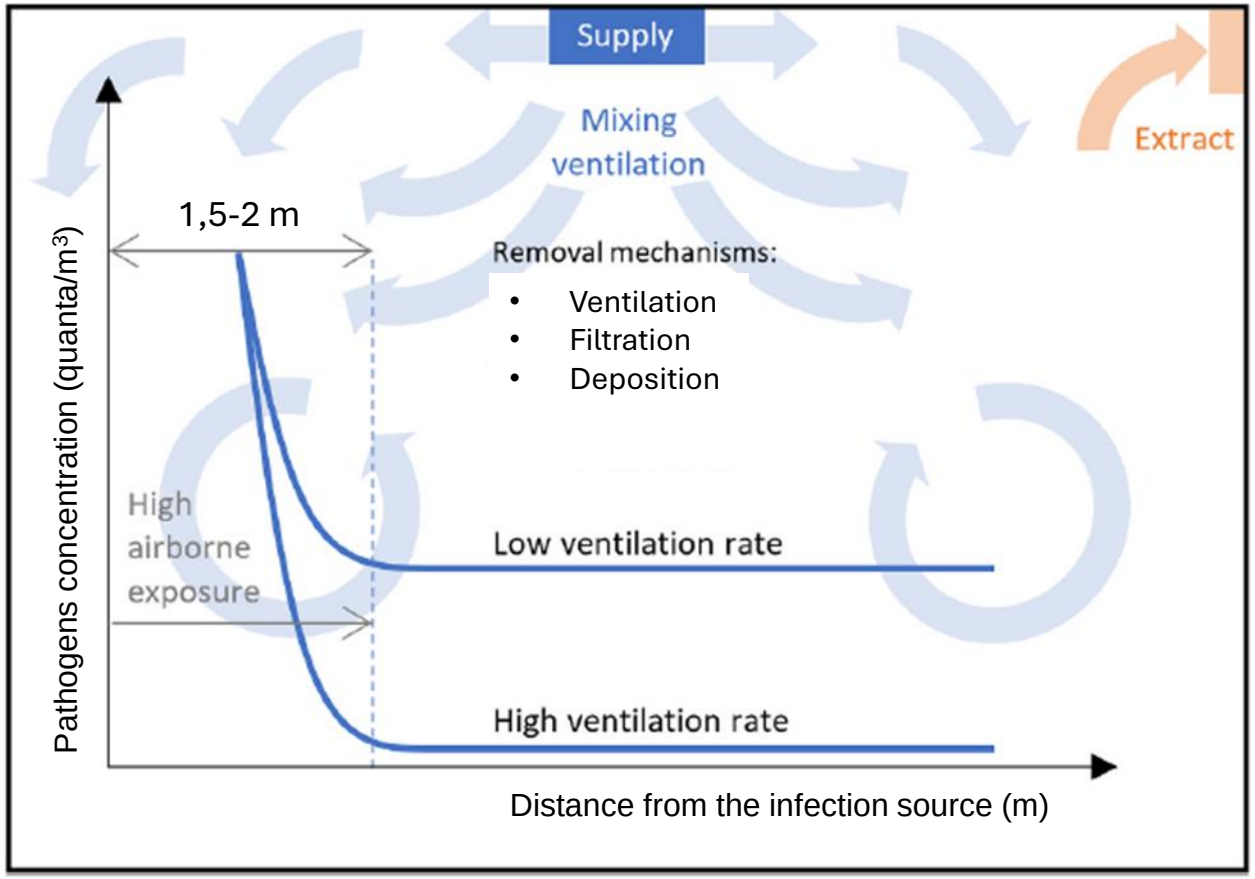
- Pathogens in respiratory particles
- Large respiratory particles : liquid > 100 µm
- Small repiratory particles : solid, liquid <100 µm



Jimenez et al., 2021

Effect of ventilation on airborne pathogens concentration in a room

Clean Airflow for Infection Risk Mitigation ($m^3/h/pers$)



Adapted from Kurnitski et al., Building and Environment, 2021

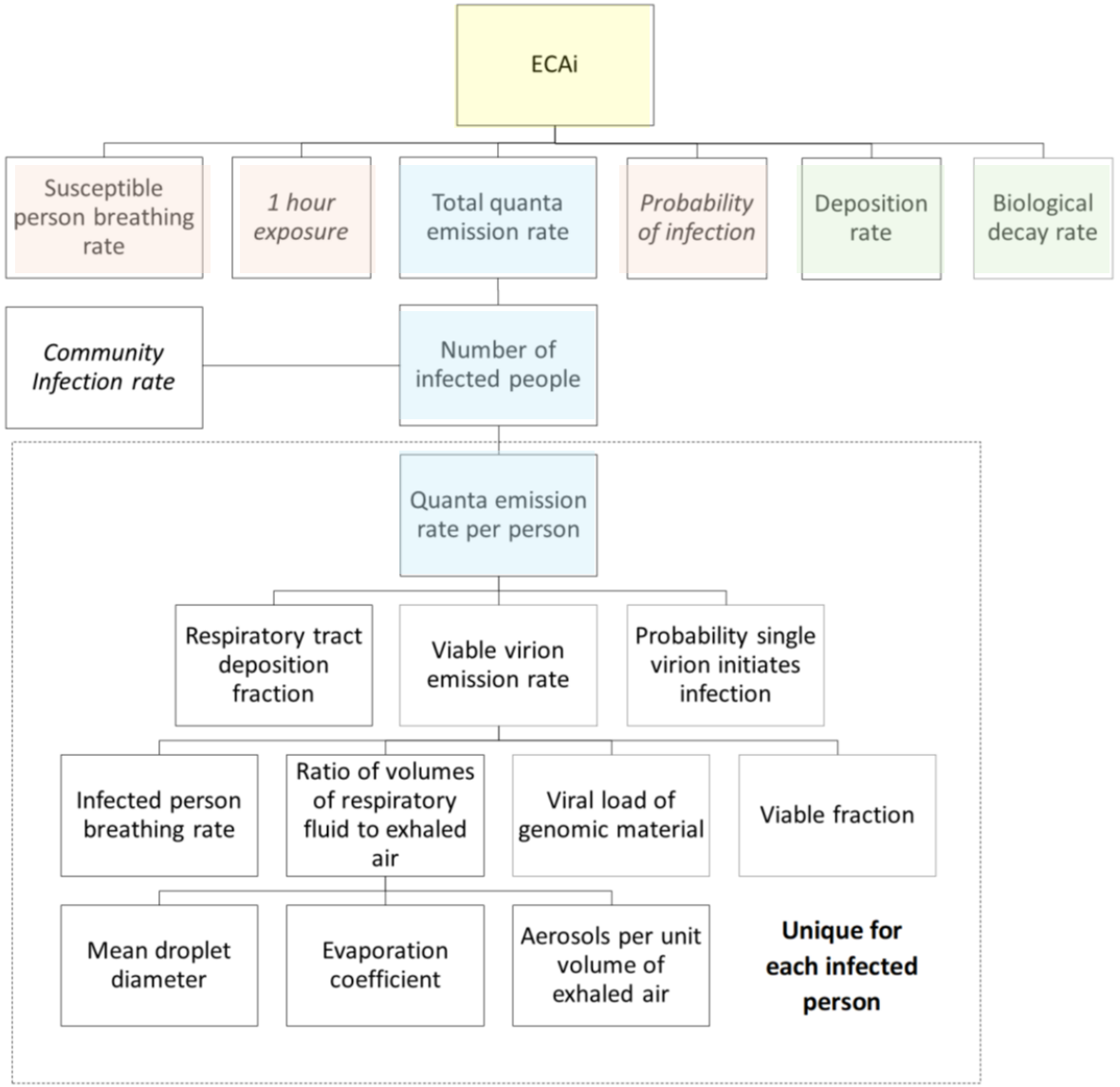
Equivalent clean Airflow for Infection Risk Mitigation ($m^3/h/pers$)

Wells-Riley model

Probability of infection for long range exposition

quanta : dose of infectious airborne pathogens required to cause infection in 63% of susceptible persons

ECAI : ventilation + filtration + other



ASHRAE Standard 241-2023, Control of Infectious Aerosols, june 24, 2023

Infection risk management mode (IRMM) during epidemic period

CT : code du travail
RSDT : Règlement Sanitaire Départemental Type
Norme NF EN 16798-1 (QAI2 et B2)
Avis du HCSP du 12/10/2023
ASHRAE Standard 241-2023
REHVA proposal for post-COVID target ventilation rates (2022)

	CT (m^3/h.pers)	RSDT (m^3/h.pers)	Norme NF EN 16798-1 (m^3/h/pers)	HCSP/IRMM (m^3/h/pers)	ASHRAE IRMM (m^3/h/pers)	REHVA IRMM (m^3/h/pers)
Office (25 m², 4 pers.)	25	18	41	50	54	48

For REHVA calculation h = 2.6 m

An infectious person will not infect more than one person during the infectious period

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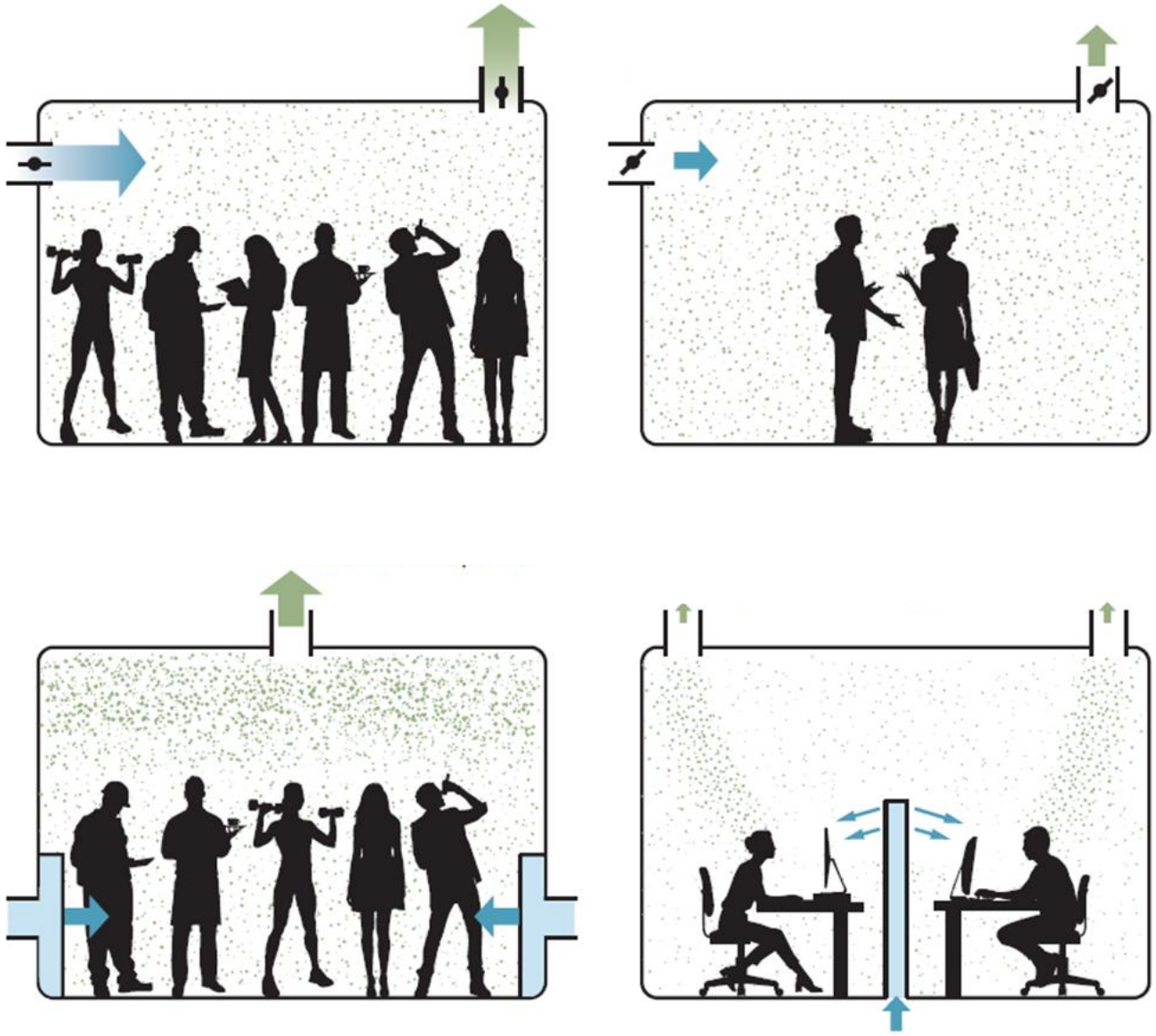
Réglementation pour les crèches, accueils de loisirs, écoles, collèges/lycées : CO2 < 800 ppm

	CT (m^3/h.pers)	RSDT (m^3/h.pers)	Norme NF EN 16798-1 (m^3/h/pers)	HCSP/IRMM (m^3/h/pers)	ASHRAE IRMM (m^3/h/pers)	REHVA IRMM (m^3/h/pers)
Primary school classroom (30 students, 1 prof., 50m^2)	25	15	48	50	72	34
CO2 (ppm)	1200	1733	*817*	*800*	*678*	*983*

CO2 emission rate per occupant of 20 L/h and an exterior CO2 concentration of 400 ppm

Other strategies ?

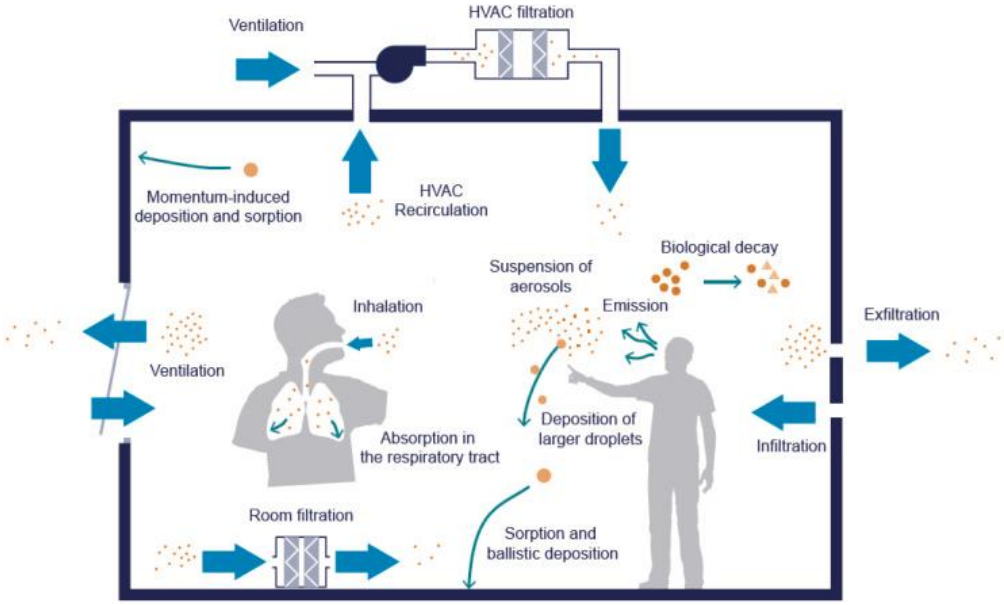
- Design for maximum occupancy
- Ajust according to the number of occupants and activities
- System designs adaptation
- Personalized ventilation



Adapted from Morawska et al., SCIENCE, 2021

Conclusion

- Adapted ventilation reduces the risk of infection for **long-range exposure**
- Ventilation strategy can help to manage infection risk in epidemic period
- Ventilation systems can be adapted to address different viruses



Jones et al., 2021

Question ?