

# **Operation Strategies of Air Conditioning System in Public Buildings during Pandemic Time**

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# Outline

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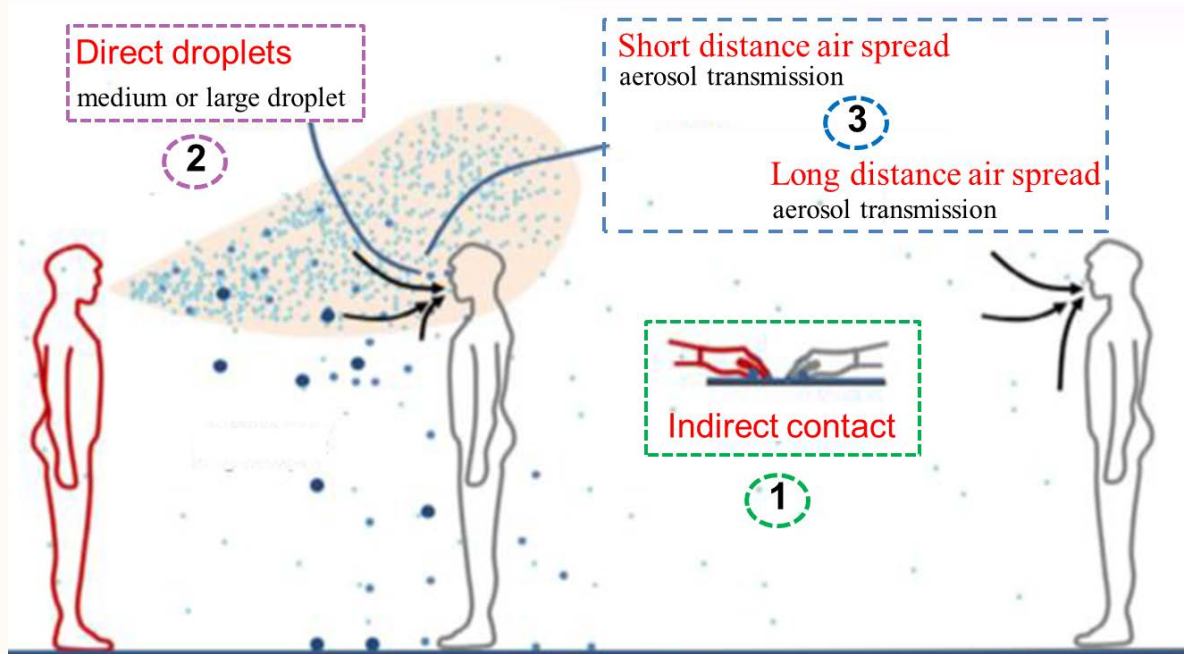
**1** Background

2 Infection Risk Analysis in Public Buildings

3 Guidelines for Operation A/C

4 Concluding Remarks

# Background



- Droplet and aerosol transmissions are very important ways for virus transmission.
- Any air-sharing system, such as **Air Conditioning Systems**, is a potential tube for cross infection.
- Operation strategies of air conditioning system in public buildings should be carefully plotted before operation during pandemic.

- Buonanno et al., 2020: Quantitative assessment of the risk of airborne transmission of SARS-CoV-2 infection: perspective and retrospective applications
- Li et al., 2020: Evidence for probable aerosol transmission of SARS-CoV-2 in a poorly ventilated restaurant
- Somsen et al., 2020: Small droplet aerosols in poorly ventilated spaces and SARS-CoV-2 transmission

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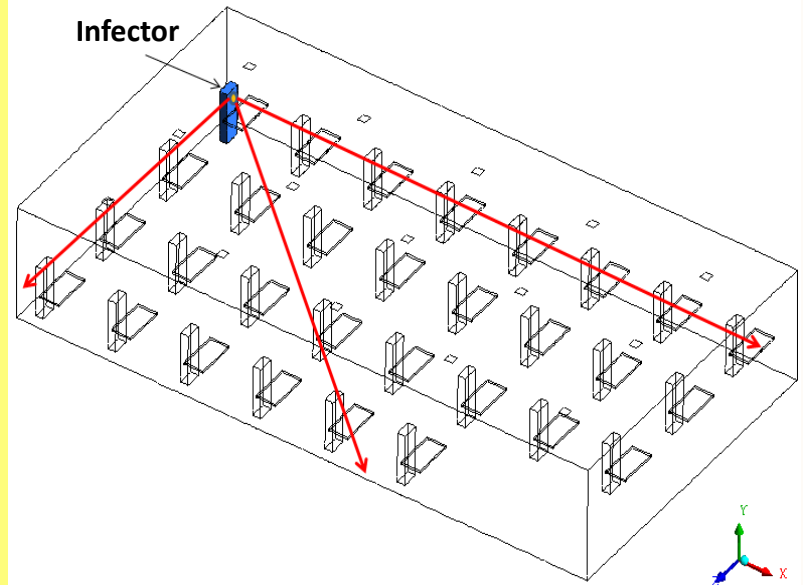
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4 Concluding Remarks

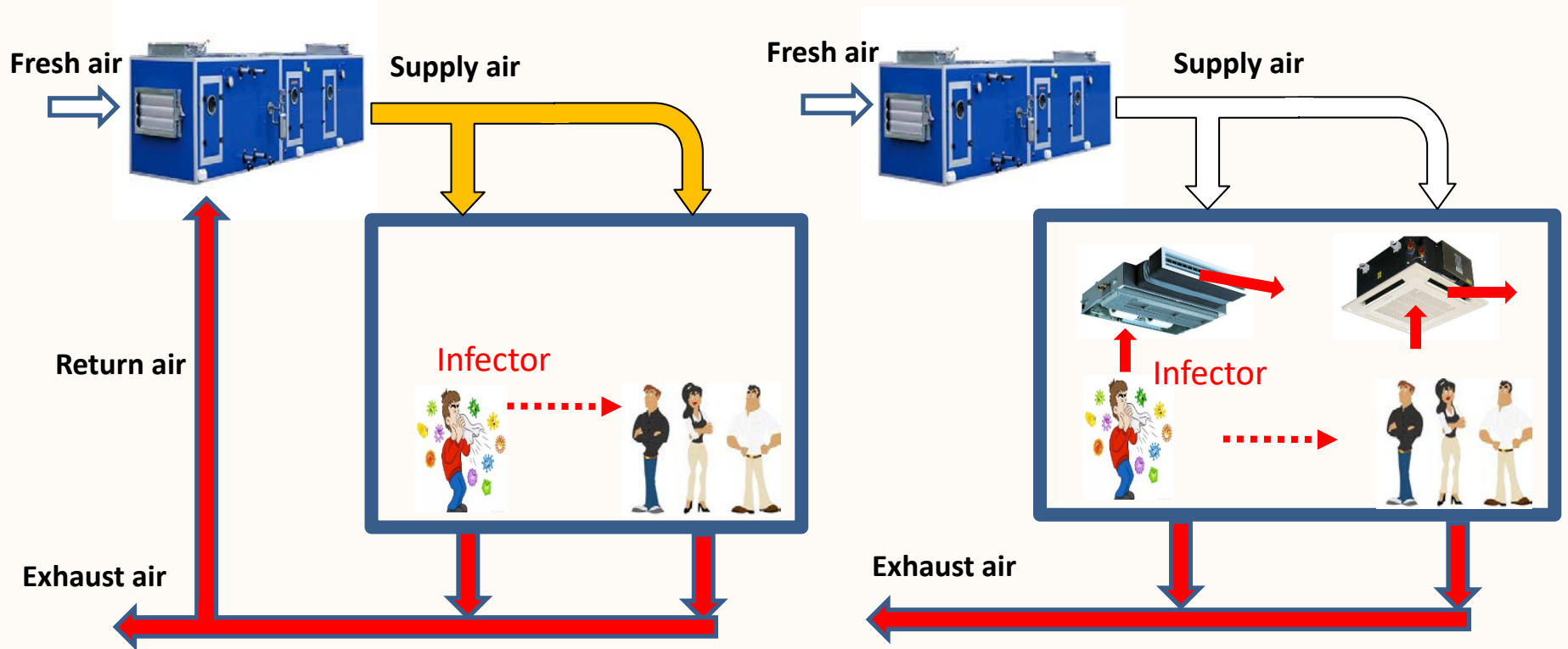
# Numerical Simulation and Probability Calculation

## Simulation settings

- Based on Wells-Riley Equation
- Using the non-uniform distribution modified model to calculate the probability
- Standard k- $\epsilon$  model
- Supply air volume: the total 'clean' air volume
- Number of infector: one
- Respiratory volume:  $0.3\text{m}^3/\text{h}$
- Volume fraction of tracer gas in exhaled air: 4%
- Exhaled air temperature:  $35\text{ }^\circ\text{C}$
- Target location: nose height, different distances along three directions (front, right,  $45\text{ }^\circ$ )
- From the actual cases of COVID-19, it is estimated  $q=10\sim 40$  quanta/h. In our study,  $q=14, 27, 40$  quanta/h is used in the analysis

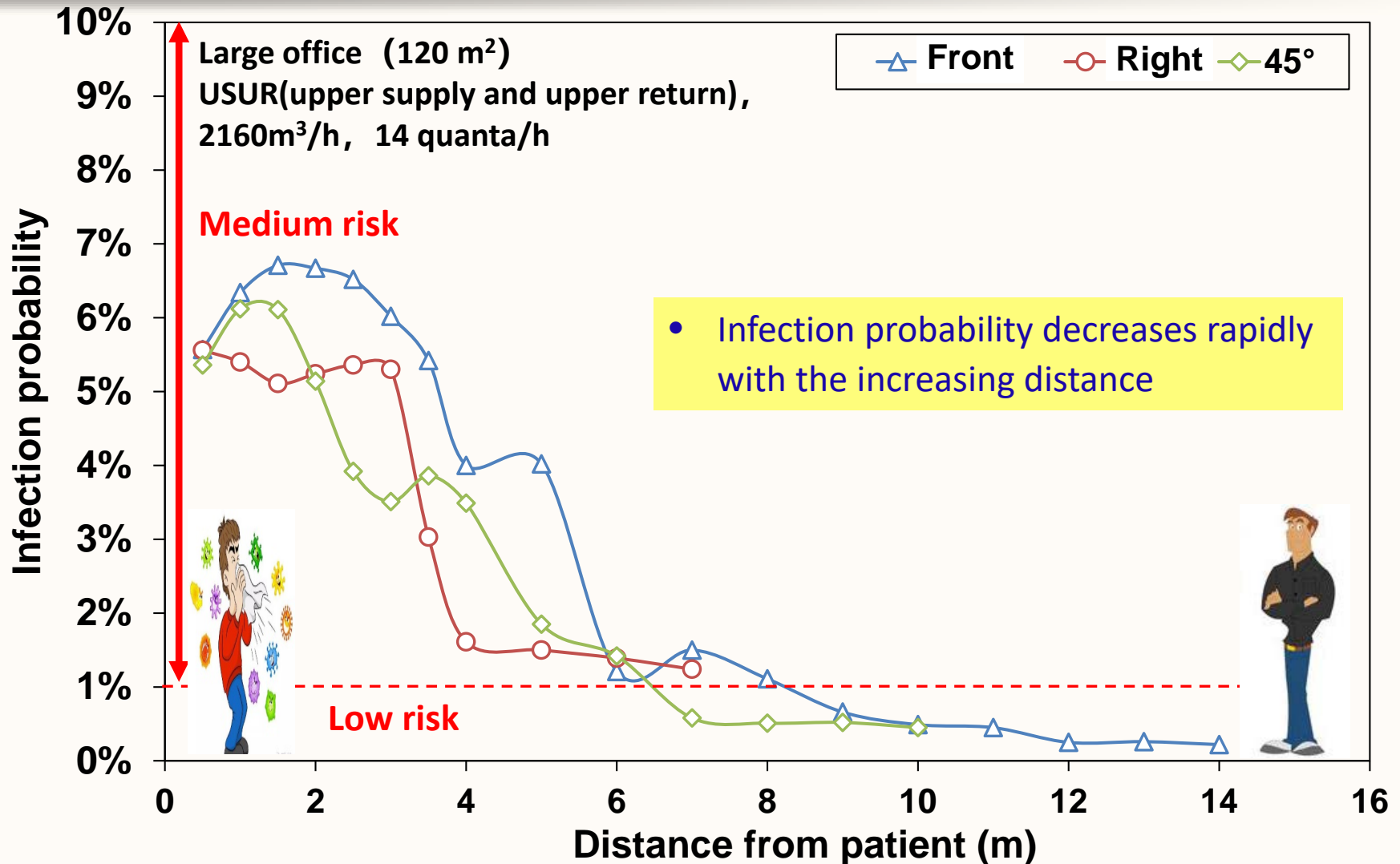


# Infection Probability *when one infector in the room*

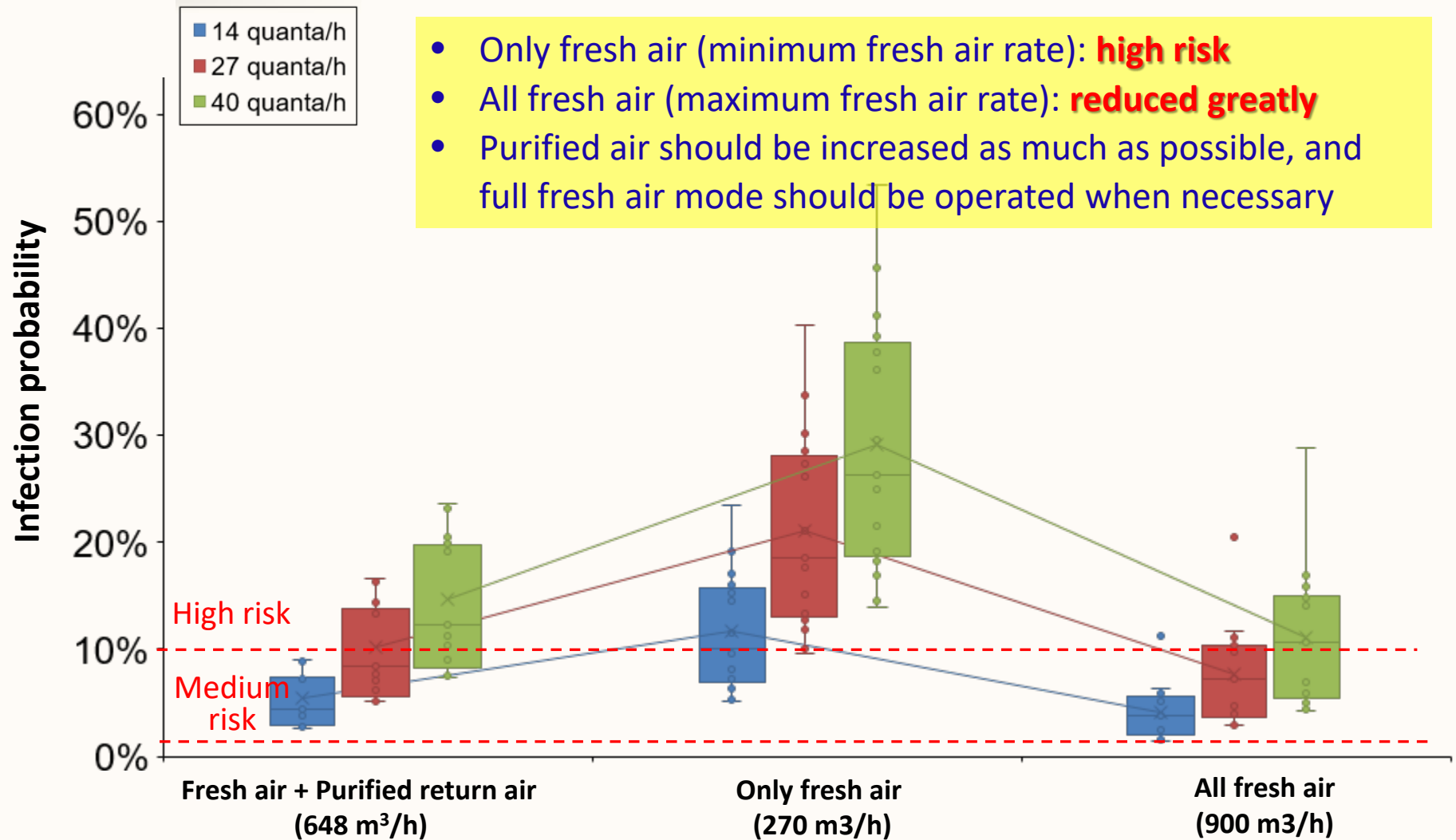


- Occupant density: 4 m<sup>2</sup> per person
- Fresh air volume per person: 30m<sup>3</sup>/h
- Least fresh air ratio: 30%
- Duration: 8 h

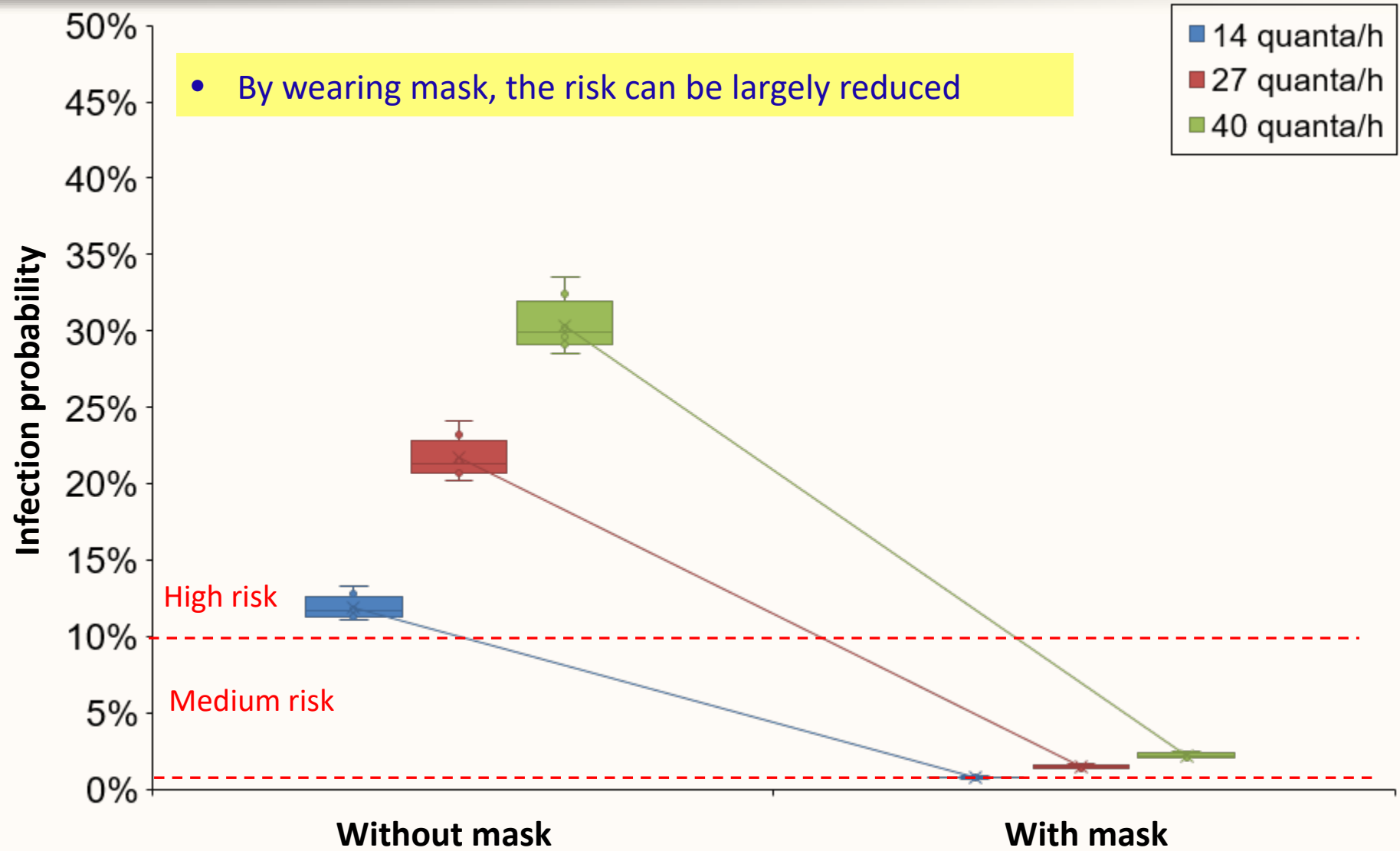
# Influence of Distance from Infector



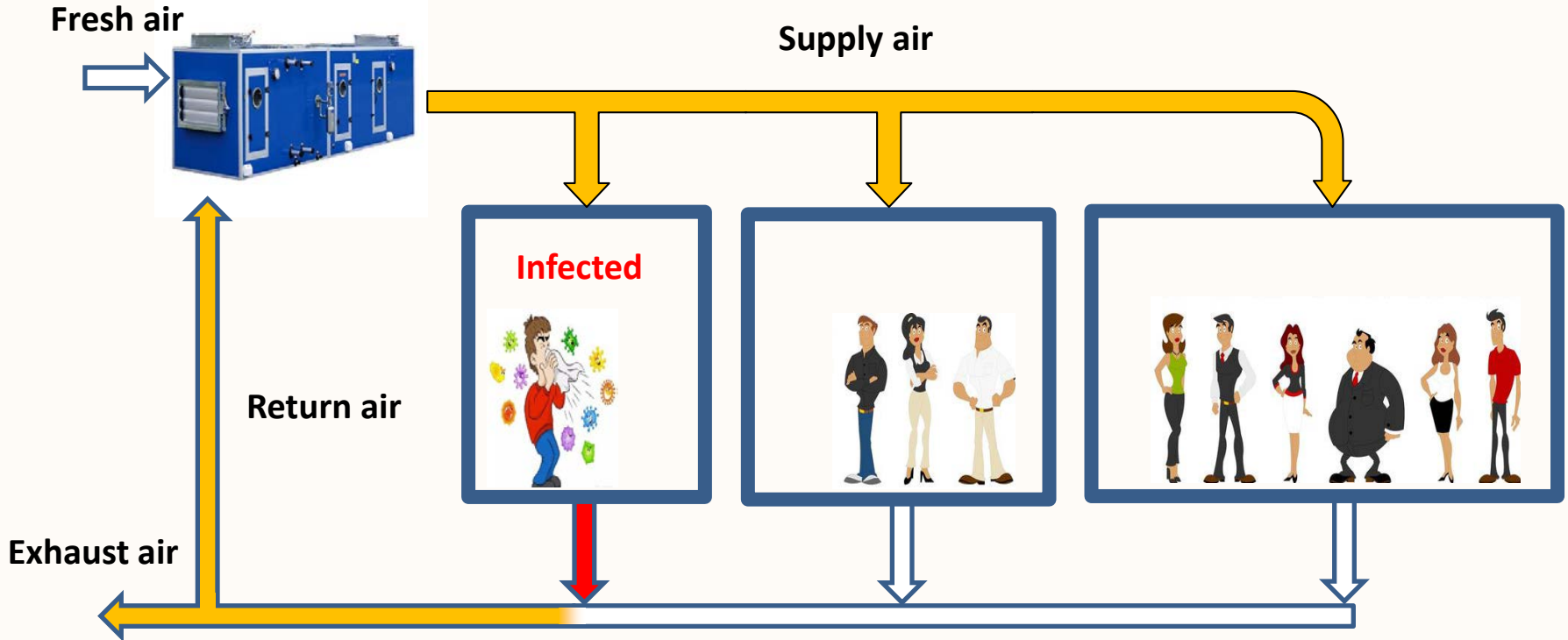
# Influence of Clean Air Volume



# Influence of Mask

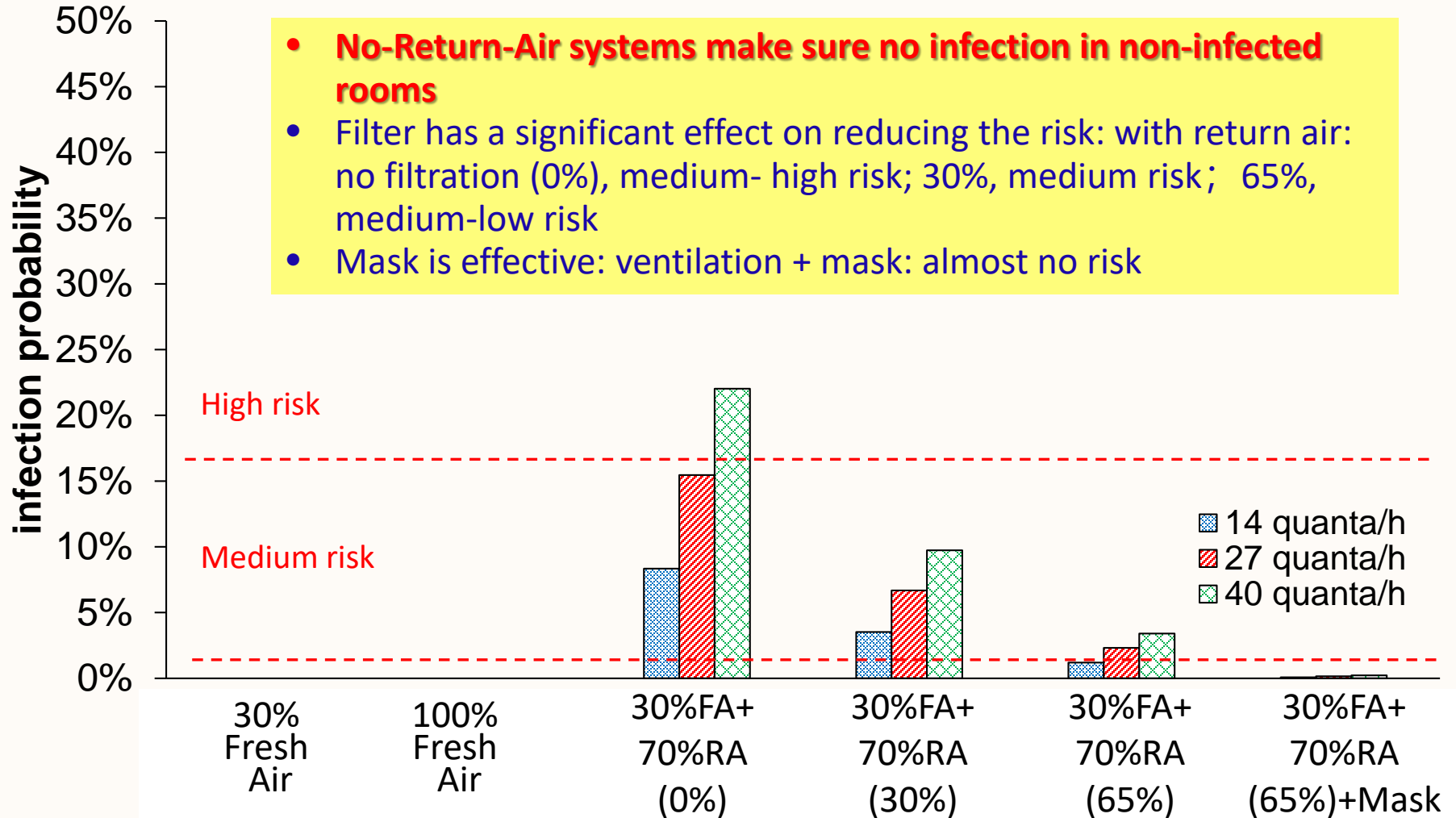


# Infection Probability *when one infector in A/C system*



- Person: 4 m<sup>2</sup> per person
- Fresh air volume per person: 30m<sup>3</sup>/h
- Least fresh air ratio: 30%
- Duration: 8 h

# Infection Probability *when one infector in A/C system*



# Remarks

- For rooms with infector, many measures can be used to decrease the infection probability, including **keeping space, using fresh air, opening window, using air purifier**, etc. But the probability can't be decreased to zero.
- For rooms without infector but sharing A/C with other rooms, **No-Return-Air systems make sure no infection.**
- For FCU/VRV + fresh air systems, medium-to-high efficiency filter should be added onto the FCU/VRV.
- Mask is a very cheap and effective way for avoiding infection.

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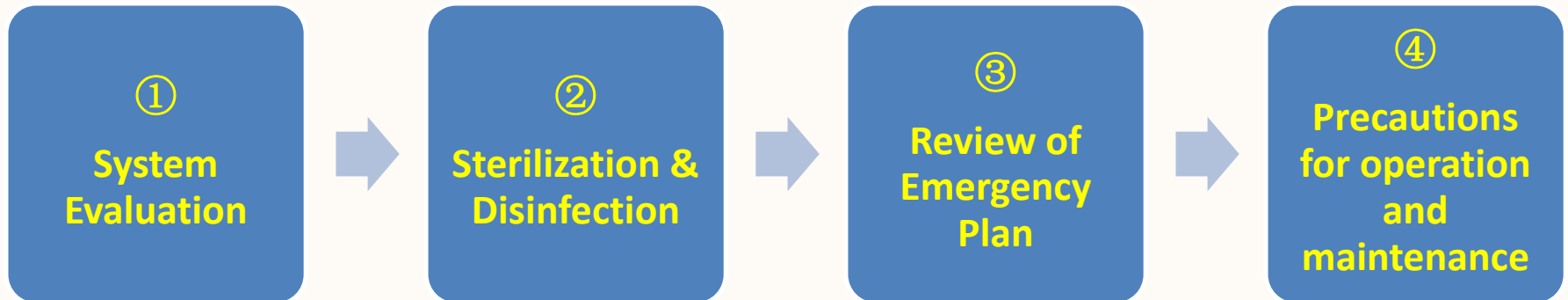
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# Guidelines for Operation A/C during Pandemic

- **The State Council:** Guidelines for Operating and Managing Air Conditioning and Ventilation Systems in Office and Public Buildings under COVID-19 Epidemic, 2020.2  
([http://www.gov.cn/xinwen/2020-02/13/content\\_5478015.htm](http://www.gov.cn/xinwen/2020-02/13/content_5478015.htm))
- **CRAA (China Refrigeration and Air-Conditioning Industry Association):** Guidelines for Evaluation of Operation, Disinfection and Maintenance on Refrigeration and Air Conditioning System in During Work Resumption under COVID-19 Epidemic, 2020.2  
(<https://mp.weixin.qq.com/s/BszoYuJ9PDeUHEqPG7lv0Q>)
- **CAR(Chinese Association of Refrigeration):** Recommendations for safely using air conditioning (heating) systems in response to COVID-19 after the Spring Festival holiday, 2020.2  
([http://www.car.org.cn/index.php?s=/articles\\_1348.html](http://www.car.org.cn/index.php?s=/articles_1348.html))

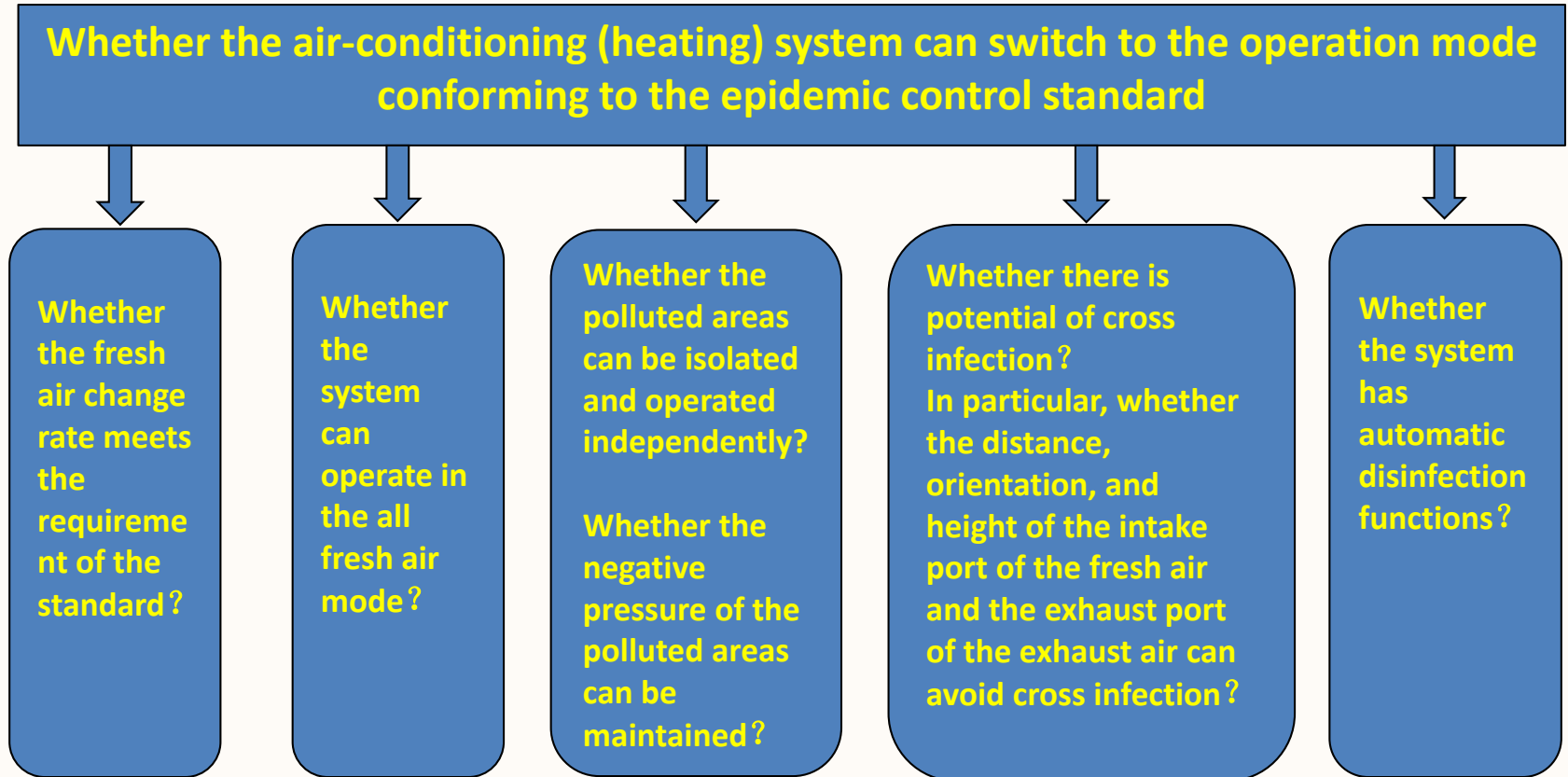
# Guidelines for Evaluation of Operation, Disinfection and Maintenance on Refrigeration and Air Conditioning During Work Resumption under the COVID-19 Epidemic

Processes to Restart the A/C (heating) Systems



# ① System Evaluation

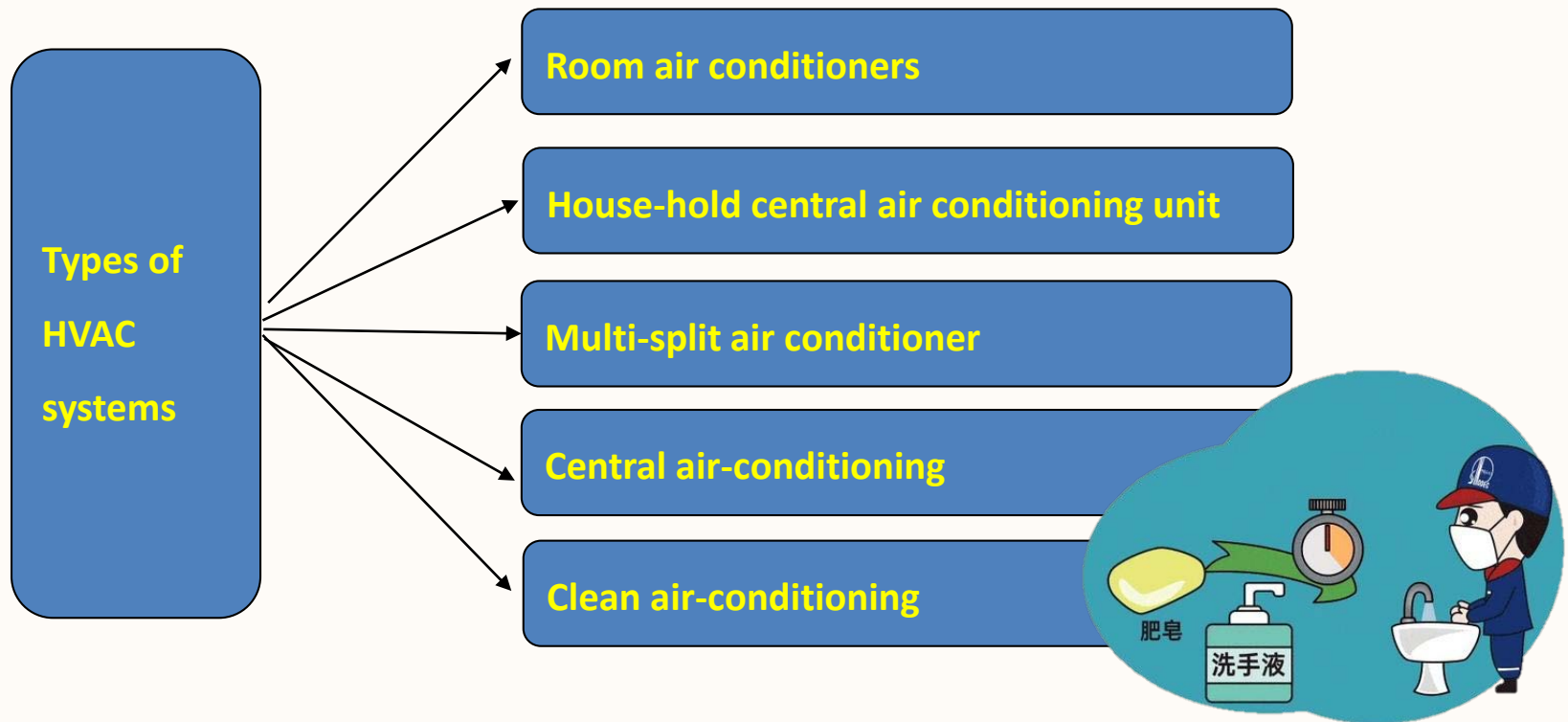
## (1) Evaluation of Functions of A/C Systems



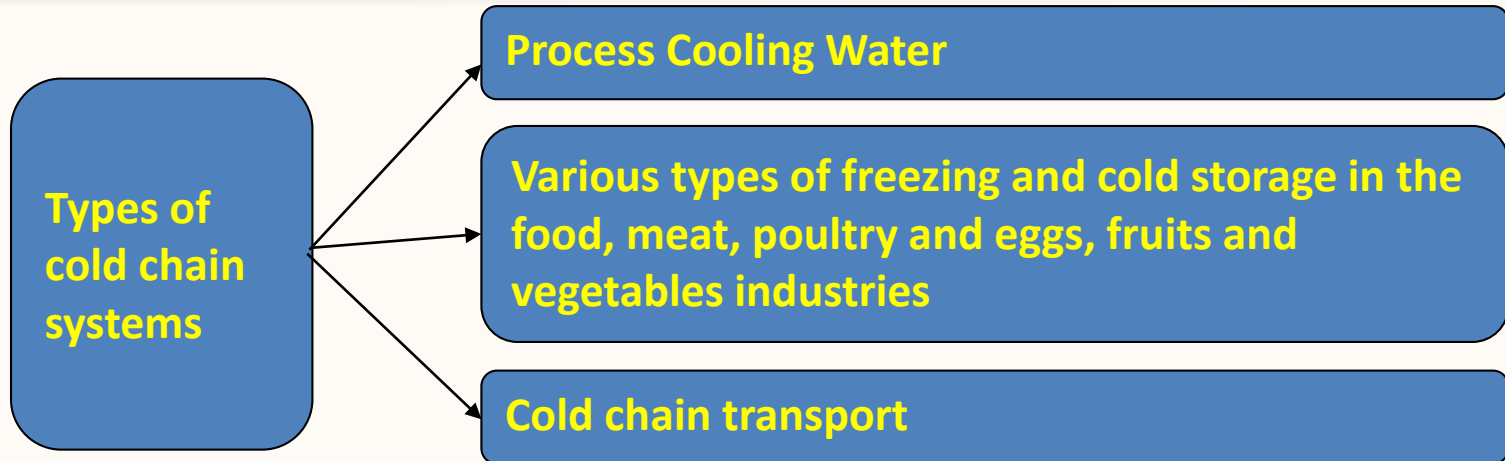
## (2) Hygiene Evaluation

## ② Sterilization & Disinfection

- During the epidemic, it is recommended that all HVAC systems should be sterilized and disinfected before restarted.
- Strictly follow the sterilization and disinfection specifications for different types of HVAC and cold chain systems:



## ② Sterilization & Disinfection



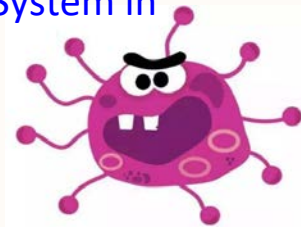
\*The sterilization and disinfection of the centralized HVAC system shall be carried out by qualified companies in accordance with national regulations as follows:

*"Sanitary Code for Centralized Air Conditioning and Ventilation Systems in Public Places" (WS 394-2012)*

*"Code for Hygiene Evaluation of Centralized Air Conditioning and Ventilation System in Public Places" (WS / T 395-2012)*

*"Code for Cleaning and Disinfection of Centralized Air Conditioning and Ventilation System in Public Places" (WS / T 396-2012)*

Other projects should be sterilized and disinfected by professionals.



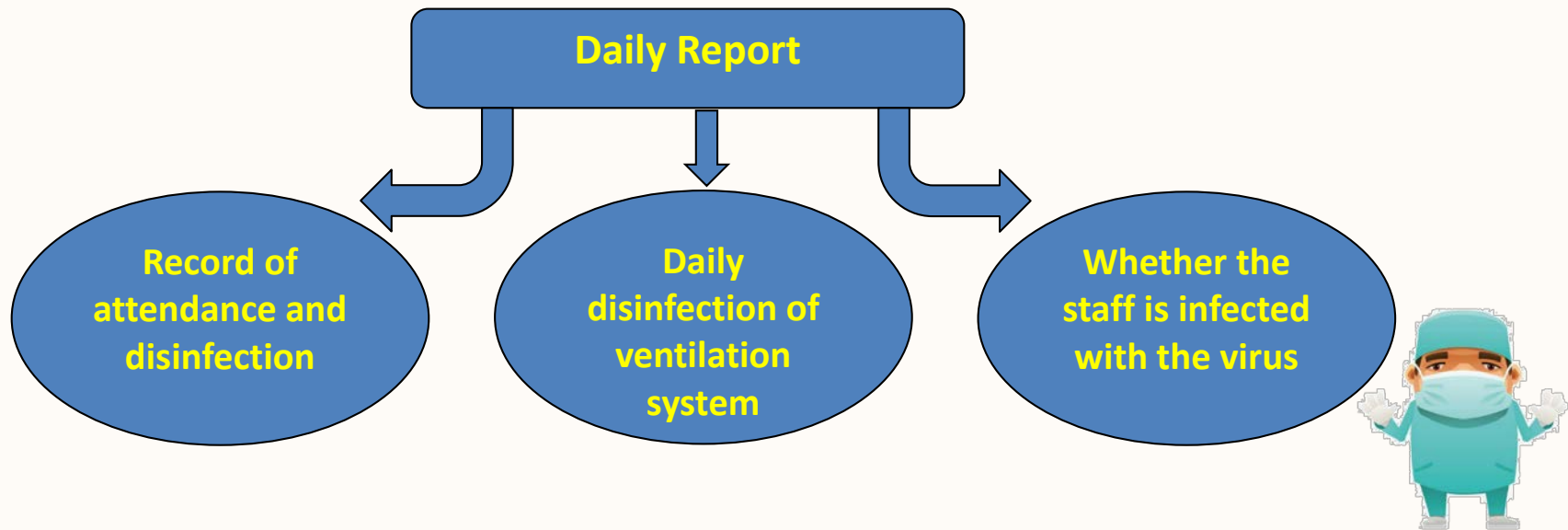
## ③ Review of Emergency Plan

**If virus contamination is found,**

- a) How to quickly report to decision-makers?**
- b) Whether shut down the system or switch to other operation mode?**
- c) Technicians must be proficient in the system isolation, fresh air adjustment and negative pressure control to avoid cross infection.**
- d) In the hospital, attention should be also paid to the exhausted air handling.**

## ④ Precautions for Operation and Maintenance

- Personal protection of technicians must be done, including washing hands, wearing masks, wearing gloves and even goggles when in special places, such as hospitals or contaminated areas.
- The technicians should strictly follow the daily report requirement.



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## Concluding remarks

- **Building air-conditioning and ventilation systems play an important role in prevention and control of the epidemic.**
- **The centralized air-conditioning system has a low risk when it is properly operated.**
- **Operation Strategies and emergency plan should be carefully prepared according to the type of air conditioning system.**

# Thanks for your attention !

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