HKU KE Lunch meeting, Oct 22, 2012, 12:45-2:00 pm, Room P-603, Graduate House

Development of a New WHO Guideline on Ventilation for Better Infection Control in Hospitals

Yuguo Li
Department of Mechanical Engineering
Faculty of Engineering

It all started with the 2003 SARS epidemics

We studied 5 outbreaks in depth:

- Amoy Gardens SARS outbreak
- PWH 8A Ward SARS outbreak
- Beijing 301 hospital SARS outbreak
- PWH 9B Ward influenza outbreak

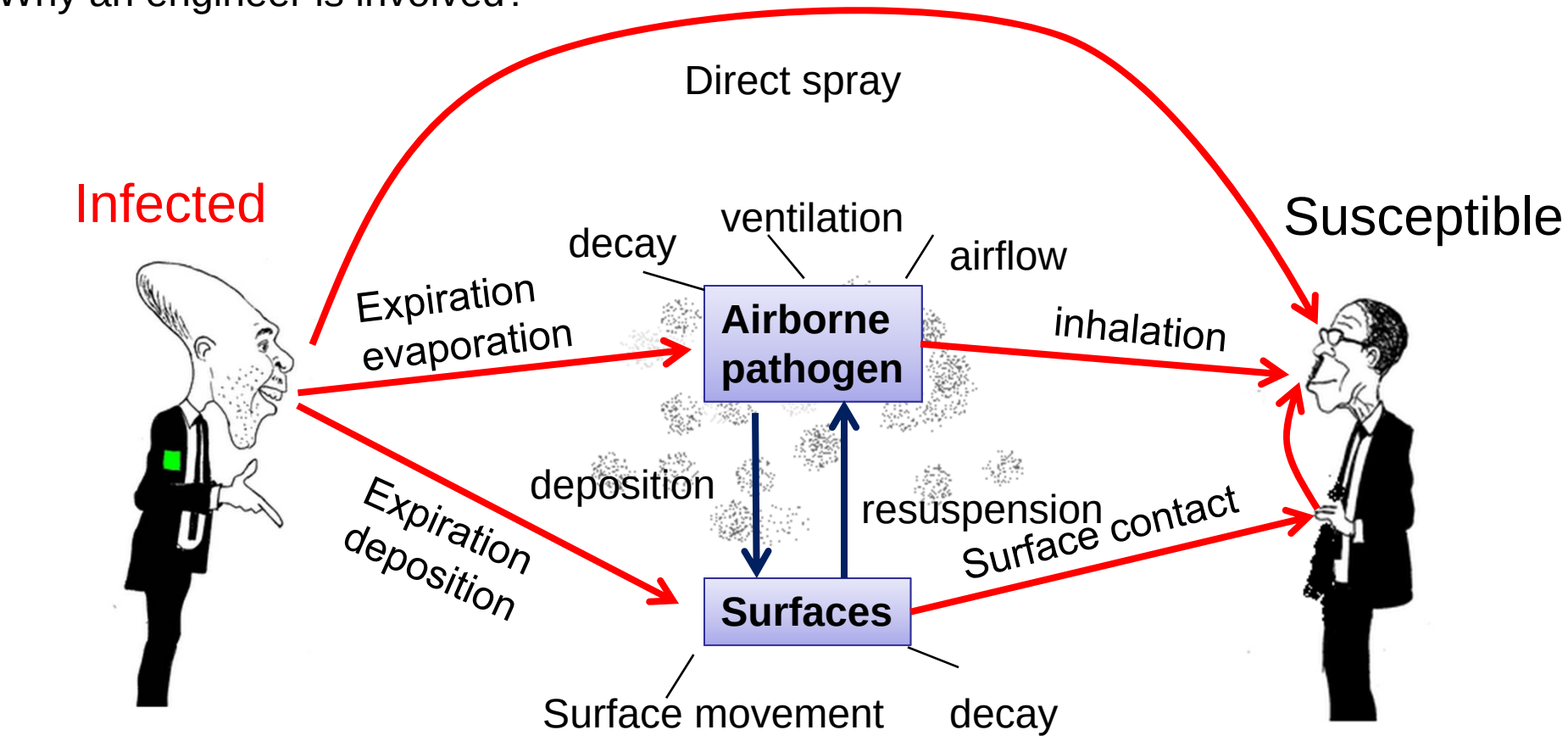
4 RGC grants
4 RFCID grants
1 NSFC grant
2 WHO grants
1 HKIE fund

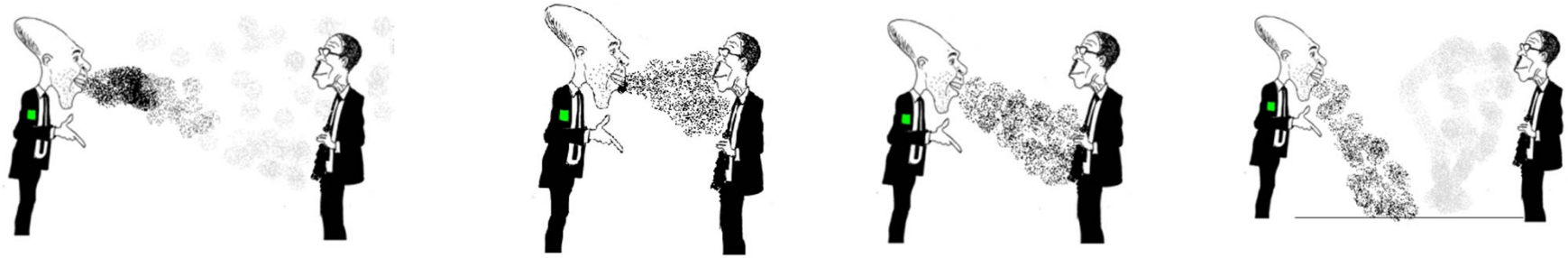
36 journal articles
(One highly cited, 2 >100 cited)
20-30 keynote/invited talks

Part of the 2010 National Science and Technology Advance Award (Second Prize)

Generation, evaporation, dispersion and exposure of expiratory droplets

Why an engineer is involved?



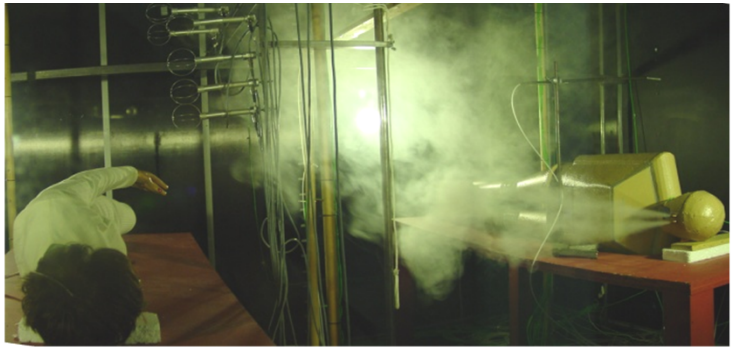


Airborne | Direct (spray) droplet | Indirect contact | Dust-borne

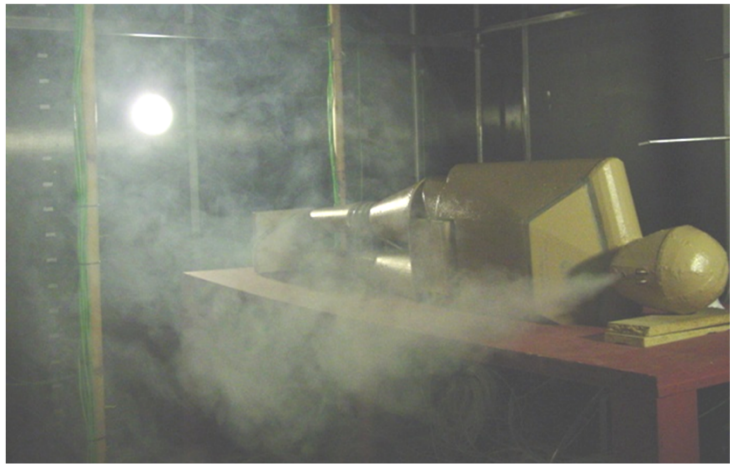
Modified from Atkinson and Wein, Bulletin of Mathematical Biology, 2008, 70:820-867

Courtesy of Prof Gary Settles

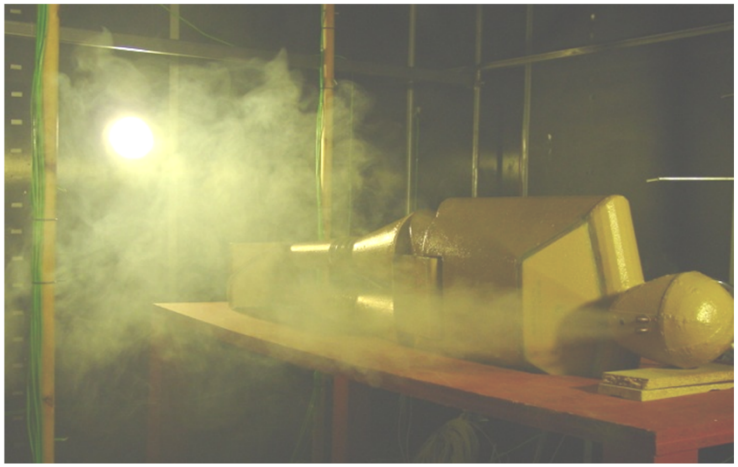
(A1)



(A2)



(B1)



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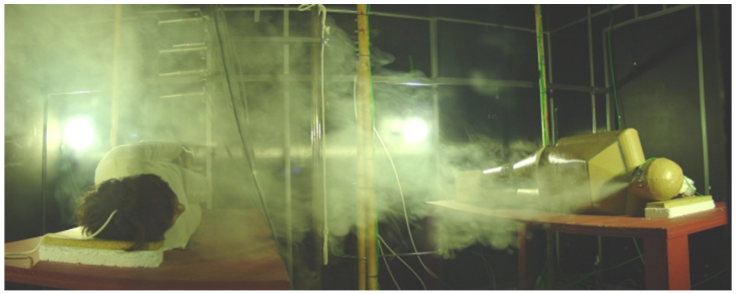

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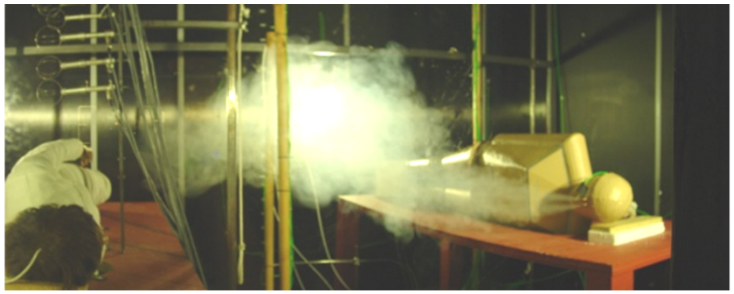
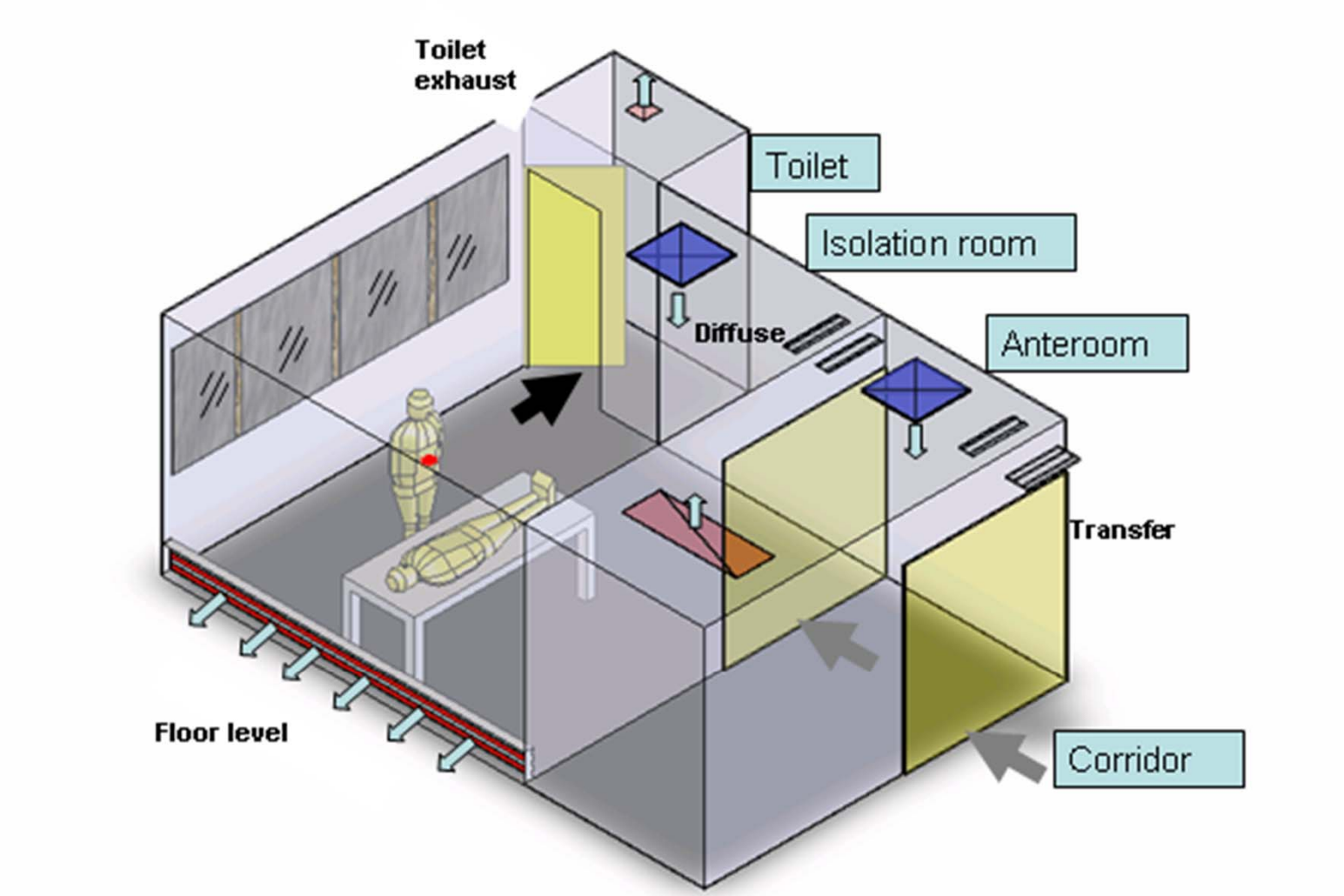


(C2)

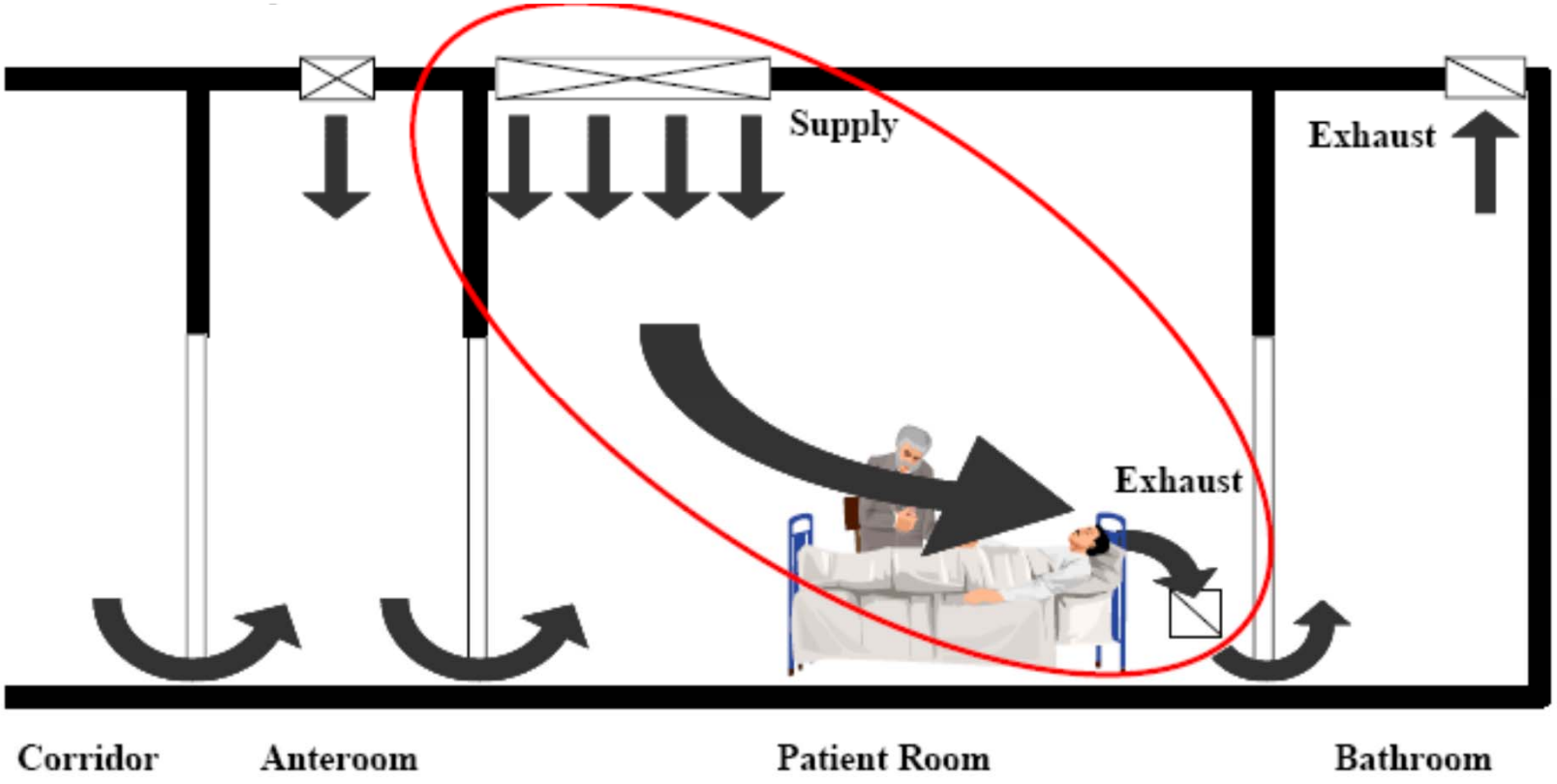
Qian et al., Indoor Air, 16:111-128, 2006.

CDC-recommended isolation room design



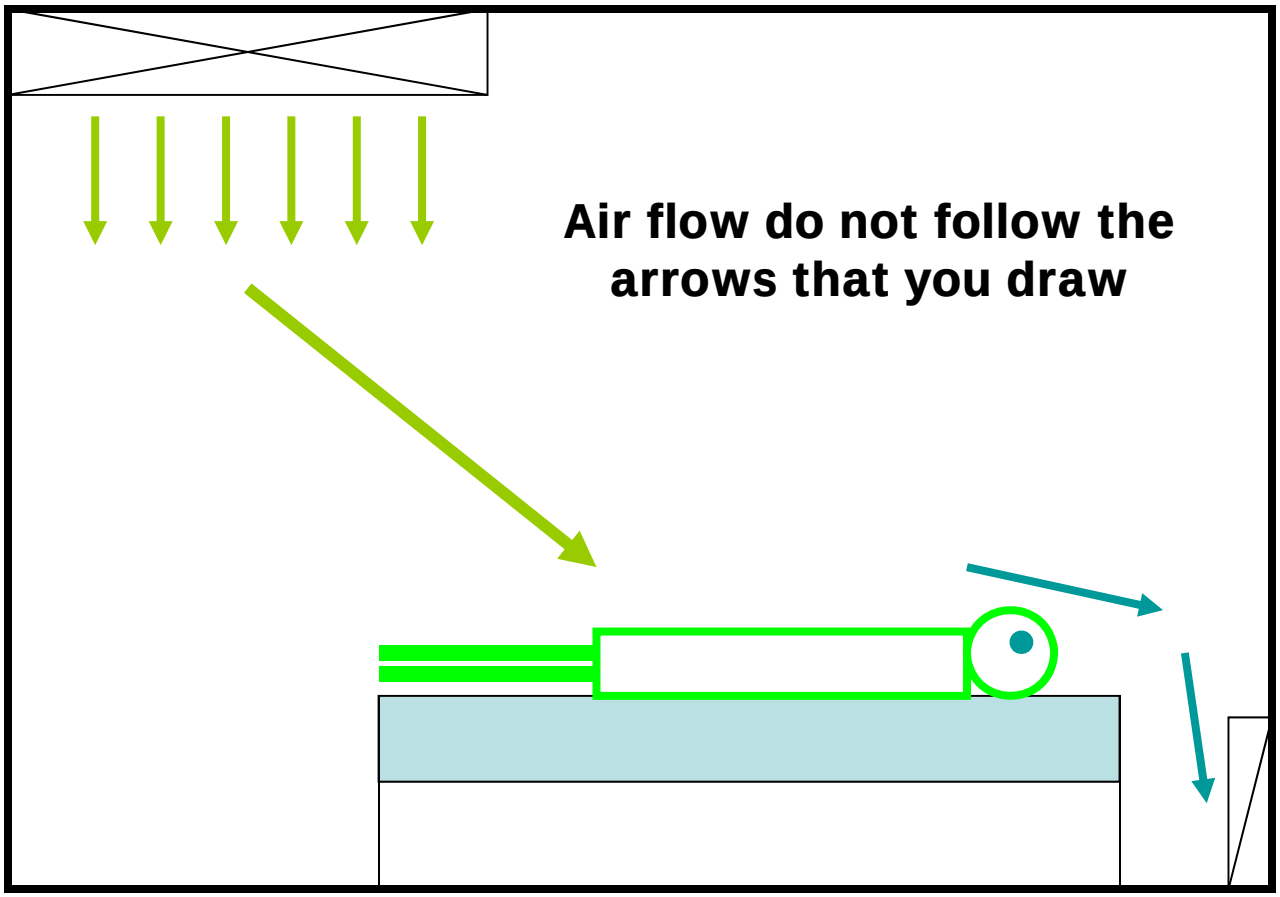
WHO Interim Guidelines, 2007, page 39
http://www.who.int/csr/resources/publications/WHO_CDS_EPR_2007_6c.pdf

Does it really work as expected???



(Left image from Internet)

Air flow can be visualized and measured, but “cannot be drawn”



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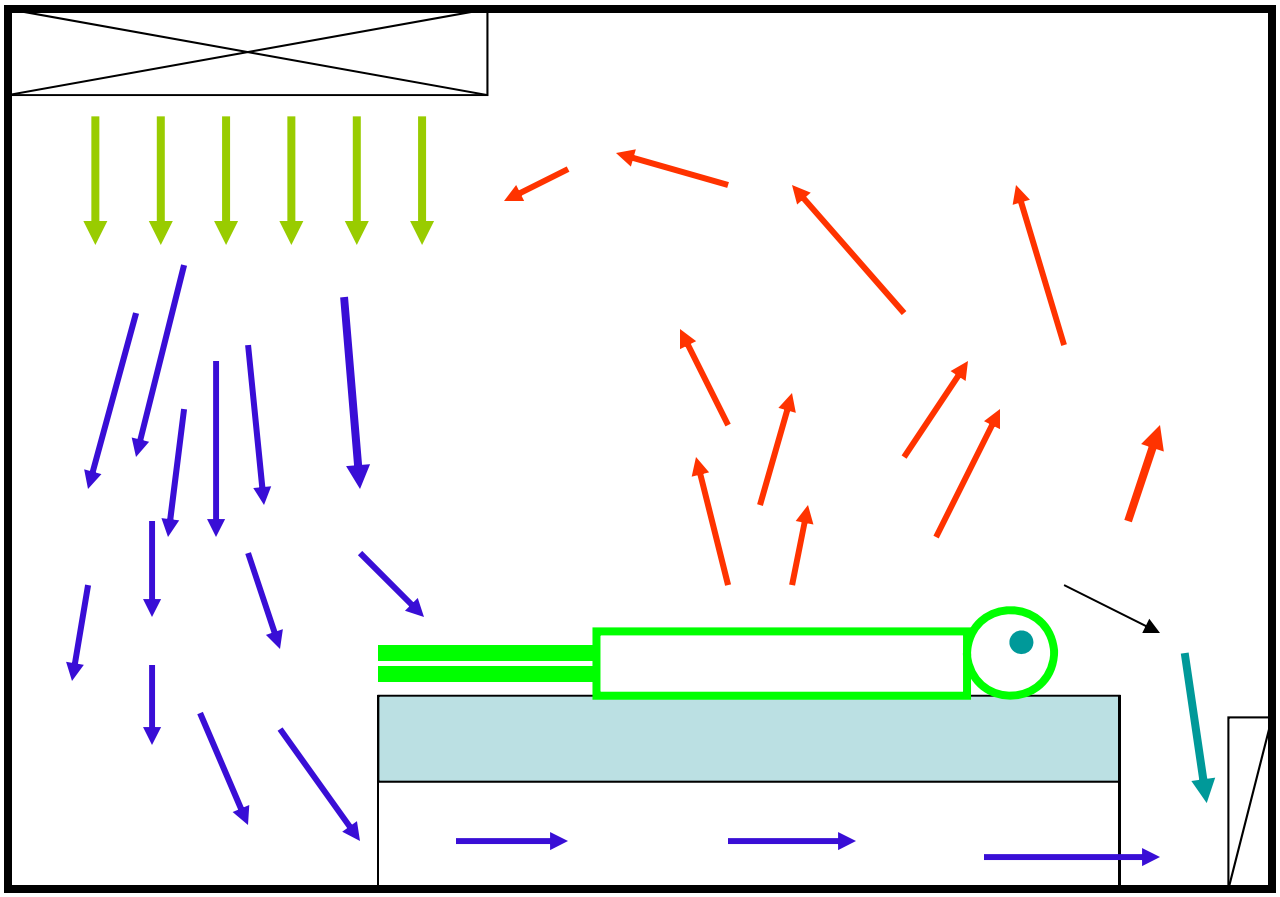
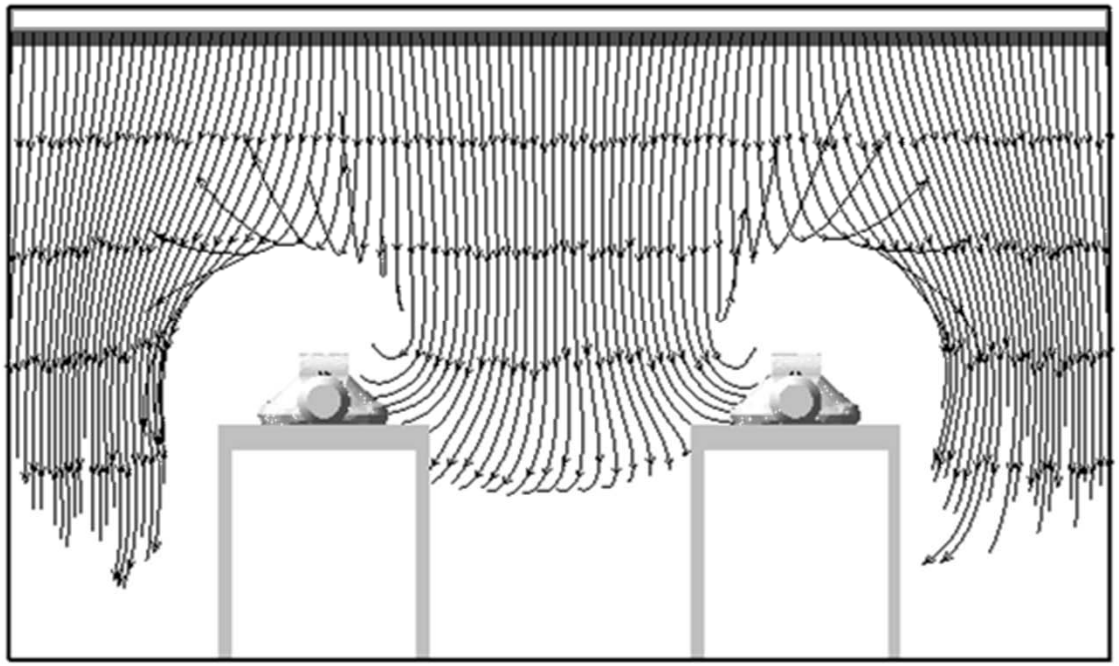
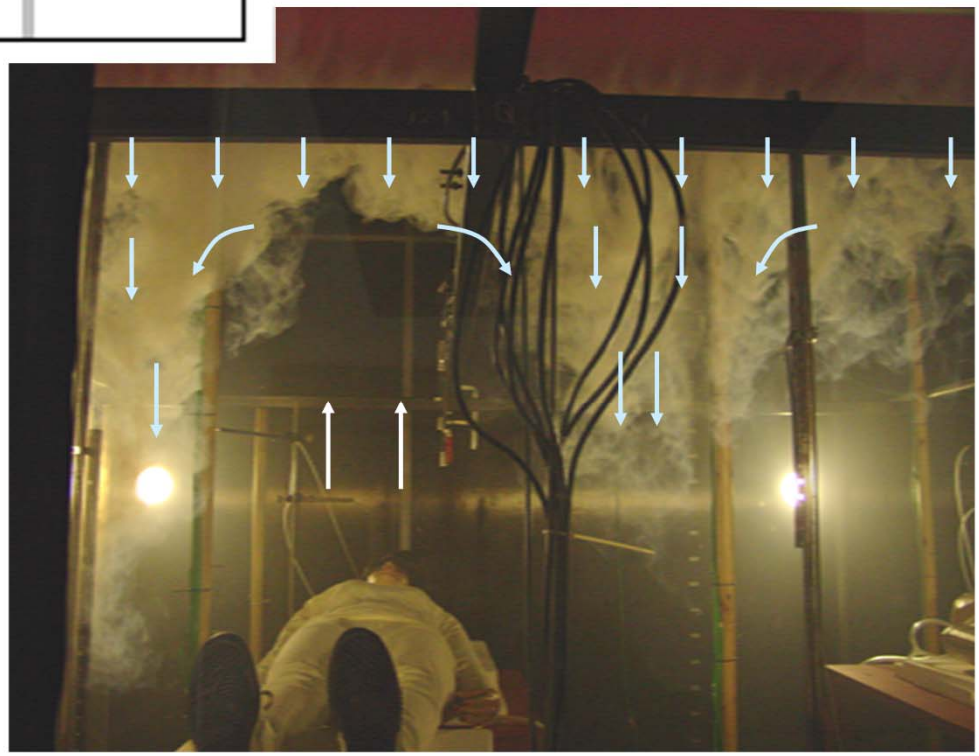


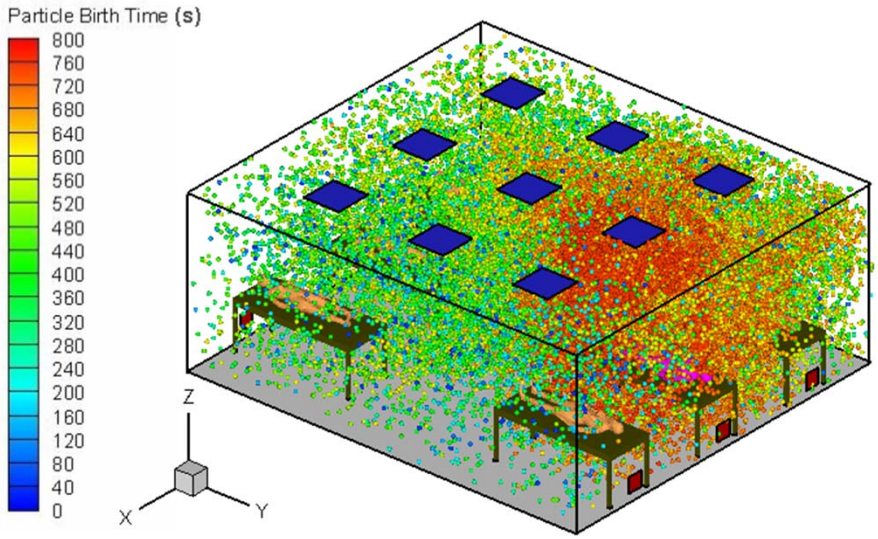




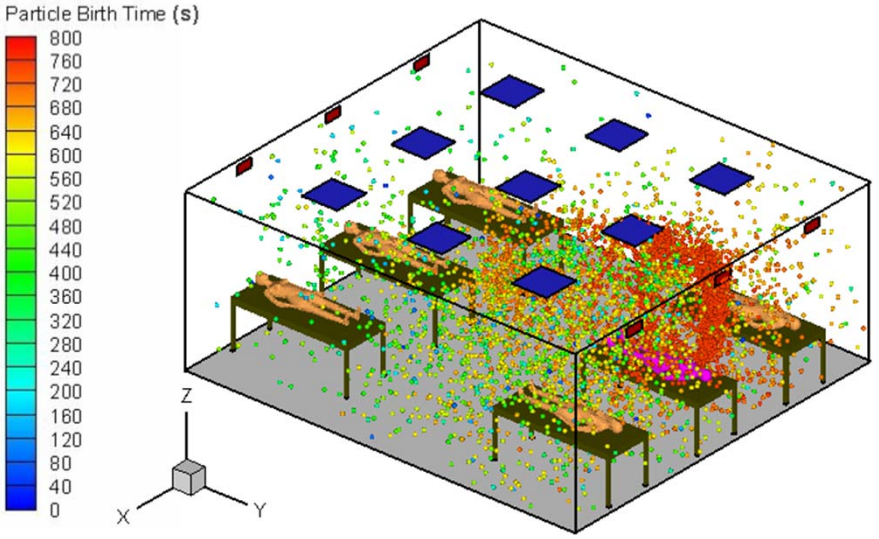
Qian et al., Building and Environment 2008;43:344-354

Xie Xiaojian, PhD thesis, HKU, 2008

D_{po}=10μm

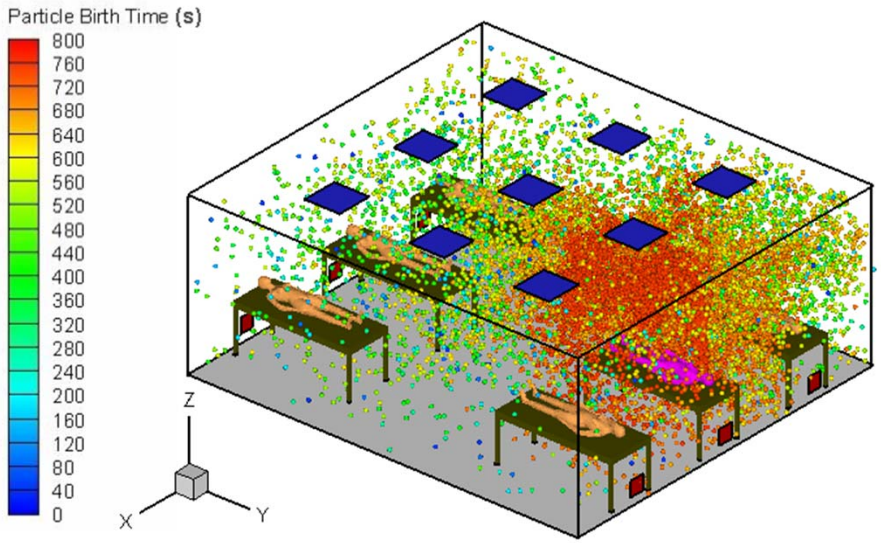


D_{po}=10μm



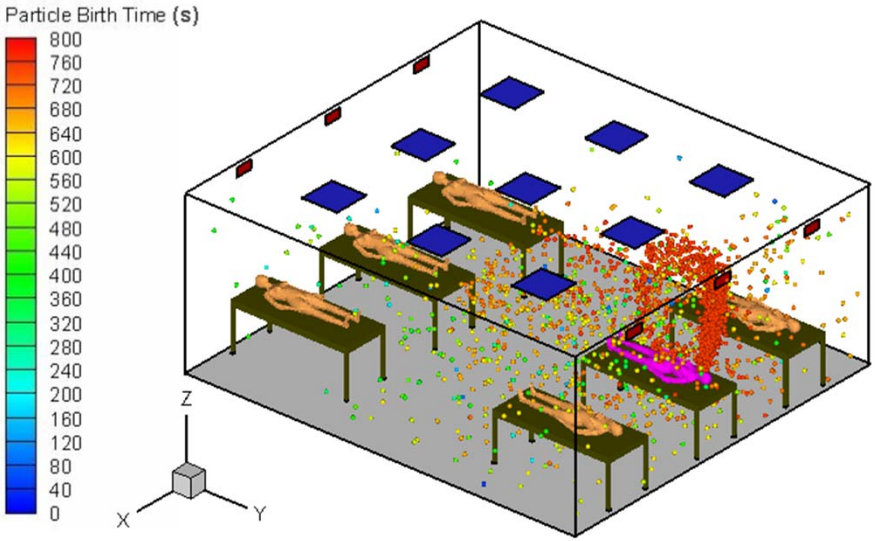
D_{po}=50μm

CDC-Low



D_{po}=50μm

HKU-New



Demonstration and engagement

HKIE SARS Busters member

传染病医院建设标准、建筑设计规范讨论会

人员名单

杨庆峰　建设部标准定额司　处长

吴路阳　建设部标准定额司　副处长

宫宗久　卫生部医政司医疗服务处　处长

焦雅辉（女）卫生部医政司医疗服务处　副处长

杨明生　北京市卫生局基建处　处长

诸葛立荣　上海市卫生局基建处　处长

吴圣明　广东省卫生厅计财处　处长

张流波　国家疾病控制中心　研究员

肖仲麟　中国建筑科学研究院　研究员

[illegible]秋琴（女）上海建筑设计研究院　高级建筑师

张春阳（女）华南理工大学建筑学院　教授

杨建国　北京协和医院　副院长

项荣培　北京地坛医院　副院长

杨淇　广州市第八人民医院　副院长

黄锡璆　北京中元国际设计研究院　建筑大师

刘　巍（女）　北京中元国际设计研究院　高级工程师

张迎新（女）　北京中元国际设计研究院　高级工程师

辛存生（女）　北京中元国际设计研究院　高级建筑师

林旬阳　北京中元国际设计研究院　高级工程师

刘燕　北京中元国际设计研究院　高级工程师

徐路　北京中元国际设计研究院　高级工程师

王健　北京中元国际设计研究院　高级工程师

郭太荣　中国卫生经济学会实业[illegible]卫生建筑专业委员会　高级工程师

丁冬（女）中国卫生经济学会实业[illegible]卫生建筑专业委员会　秘书长

崔颖盾　广东电器[illegible]事长

Program – Visit by the Mainland Deleg

9:30 am – 11:30 am, Wednesday 17 Marc

9:30 am	Arrival
9:40 am	Introduction by YL (Powe
10:00 am	Lab Demonstration (SARS
10:30 am	Lab Demosntration (Dry/w
11:00 am	Discussion (YL)

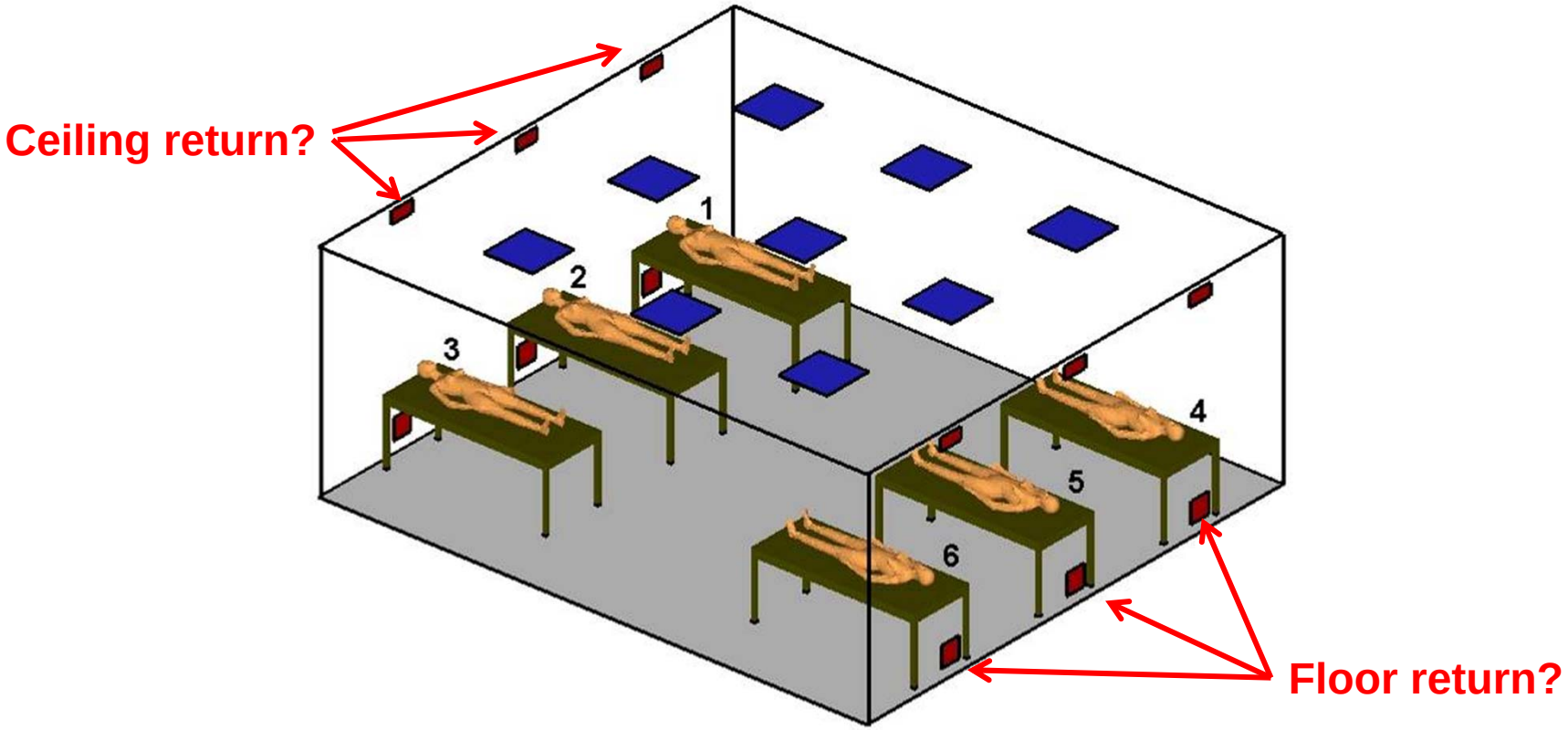
Hospital Authority, CHP, Dept of Health, WHO, China
HKIE, ASHRAE, CIBSE…

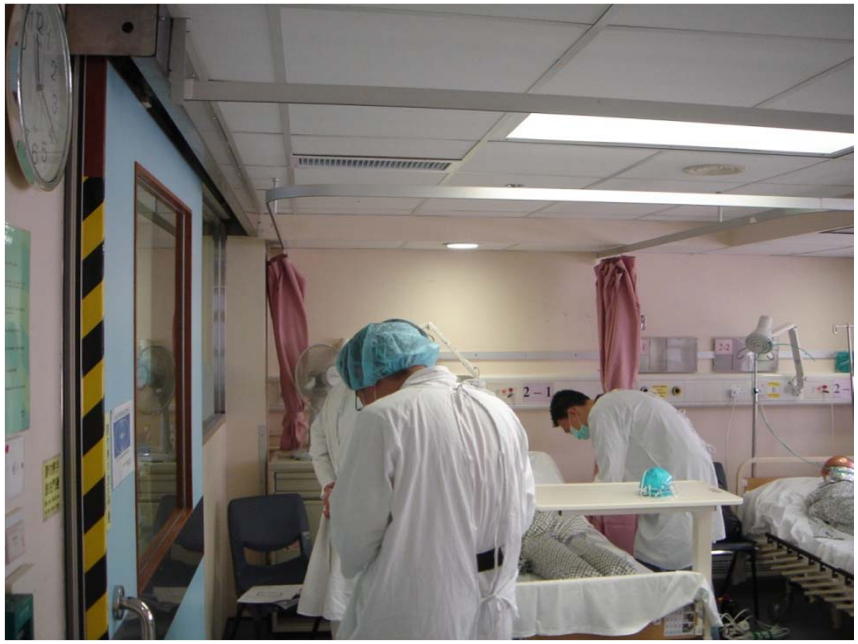
List of donors and supporters

HKIE SARS Fund, financial support
Faculty of Engineering, HKU, financial su
Atal Engineering Ltd, AC installation, testi
Efatar, chiller and primary air unit
Johnson Control, Perforated diffusers
Air Trade Centre, Pre-fabricated PU ducts
Meco Engineering, Lighting panel
Leo Engineering, Construction of the roon
QMH, Hospital beds and lockers
AET Flexible space, Smoke generators
City University, laboratory equipment
HKUST, laboratory equipment support
PolyU, laboratory equipment support
City Hall, lighting for smoke visualization

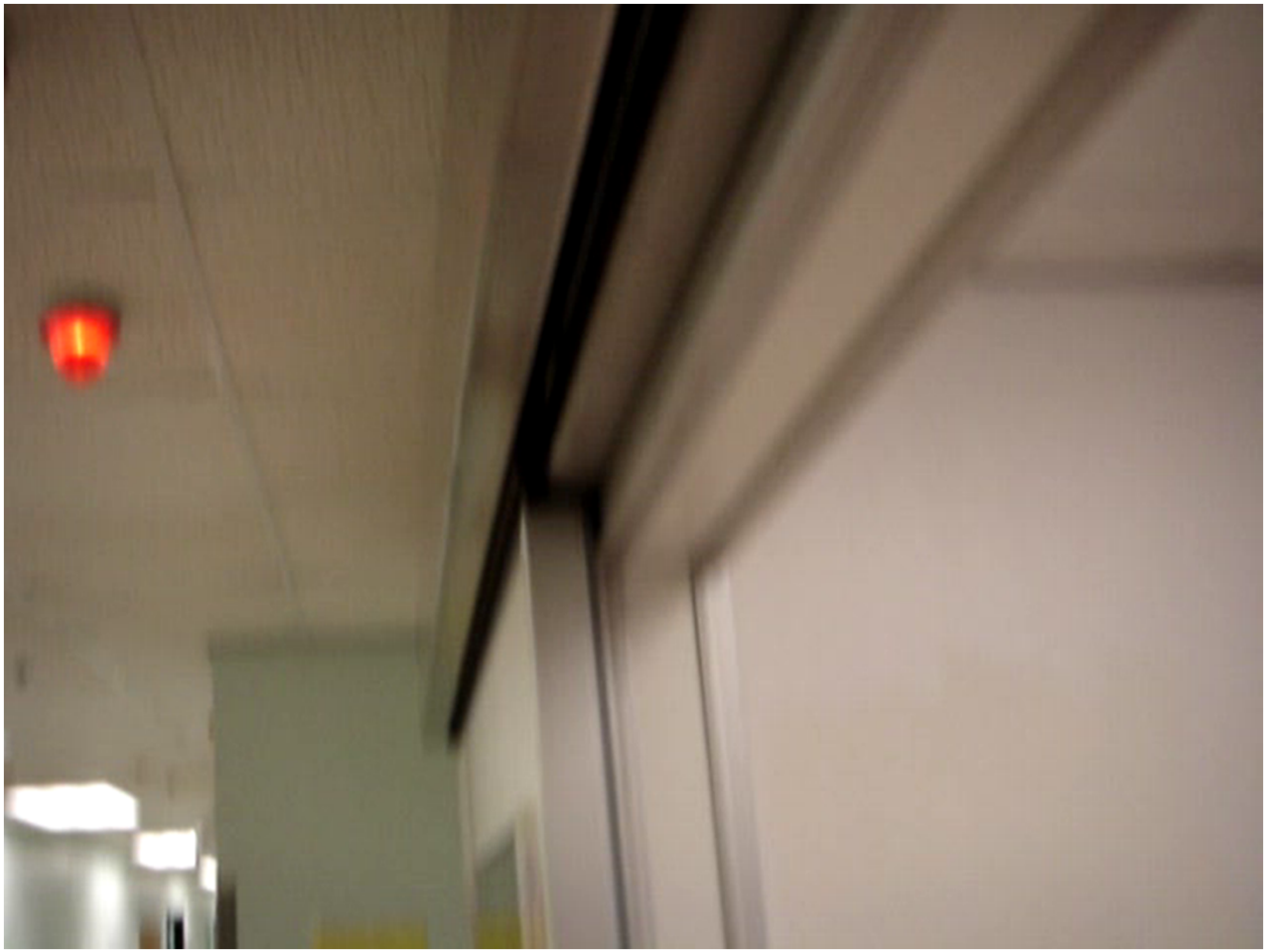
We chair ASHRAR HK Taskforce, ISIAQ Taskforce, HA roundtable forum, etc.

一个典型的美国国家疾病预防和控制中心推荐的多床位监护房－香港大学全尺寸测试舱





Any air leakage from this SARS ward?



Policy development phase

Led and developed WHO 2009 guideline
on natural ventilation and infection (2006-2009)
(now in French and Spanish)

Drafted the WHO 2007 infection
control interim guideline (ventilation chapter)
(Now in Arabic, French, Spanish, Bahasa Indonesia)

Panel member of WHO2009 TB guideline
systematic literature review

ASHRAE Position paper on airborne infection

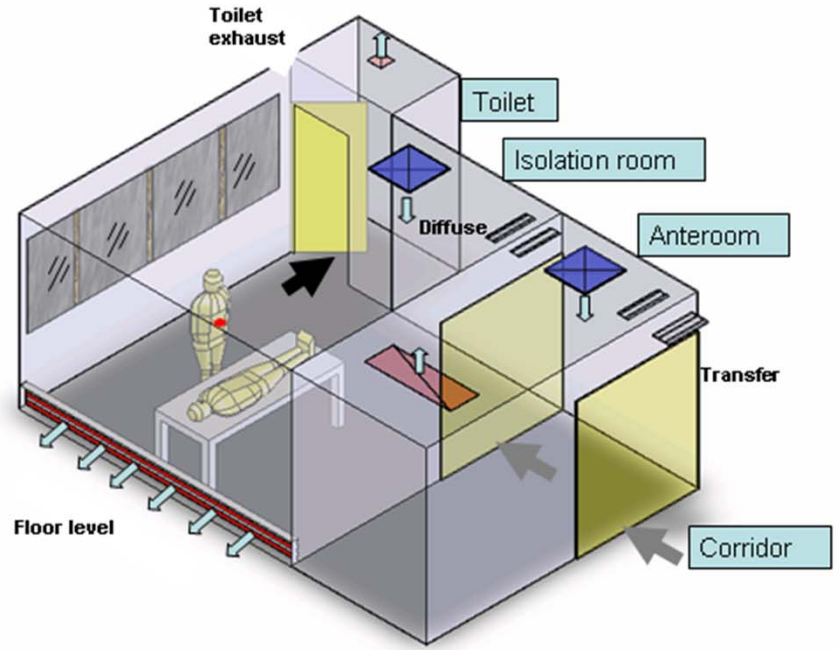
Assist Hospital Authority in local hospital ventilation
and filter design

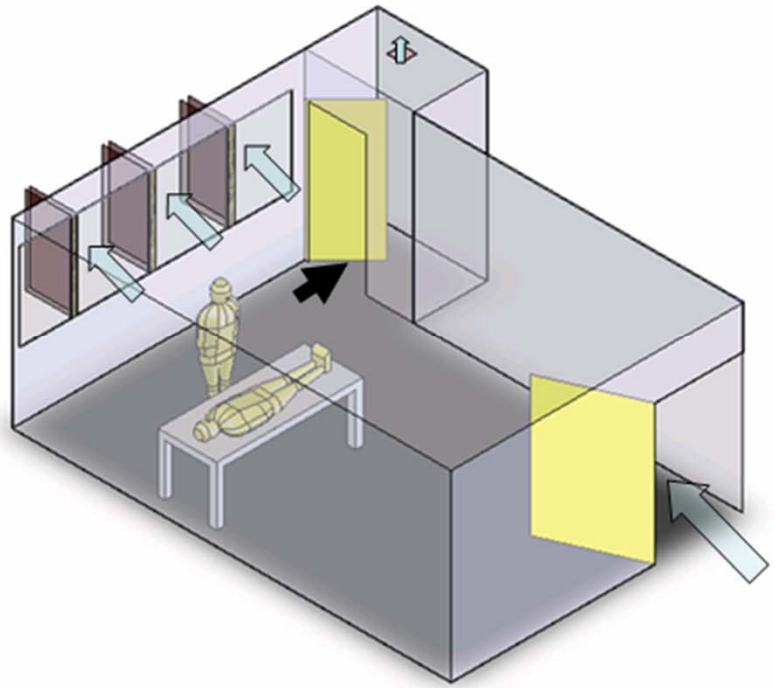
WHO Publication/Guidelines

Natural Ventilation for Infection Control in Health-Care Settings

Edited by:
James Atkinson, Yves Chartier, Carmen Lúcia Pessoa-Silva, Paul Jensen, Yuguo Li and Wing-Hong Seto

Mechanical or natural ventilation?





"The very first canon of nursing, the first and the last thing upon which a nurse's attention must be fixed, the first essential to the patient, without which all the rest you can do for him is as nothing, with which I had almost said you may leave all the rest alone, is this:

To keep the air he breathes as pure as the external air, without chilling him."

Florence Nightingale (1820-1910), Notes on Nursing, 1860.

Grantham Hospital -A TB hospital that has been naturally ventilated since 1950s

Spot cooling

Open windows for 24 hrs a day and 365 days a year

The timeline

- Sept 2006 – Invited to write a chapter on ventilation in the new WHO interim infection (IC) control guidelines
- Dec 2006 – Invited to draft a Natvent guideline
- July 2007 – WHO releases the new IC guidelines
- May 6-10, 2007 – WHO Natvent consensus meeting, HK (Per, Derek, Takao, Jialei, Seto, Pat, Yves)
- Dec 2007 – NatVent guideline first draft for comments
- Feb 2008 – NatVent guideline 2nd draft
- May 2008 – Invited to do systematic reviews
- Sept 29-30 2008 – HK assessment workshop
- 16-17 Nov 2008 - Adrian and I report to WHO in Geneva
- Dec 10 2008 – NatVent guidelines WHO first draft submitted
- June 2009 - Released

We cannot even get consensus in photo taking!

A slide from the meeting

What is consensus?

- Consensus - the ISO/IEC Guide 2 definition http://www.etsi.org/about_etsi/30_minutes/yes/informalway_a.htm

- "General agreement, characterized by the absence of sustained opposition to substantial issues by any important part of the concerned interests and by a process that involves seeking to take into account the views of all parties concerned and to reconcile any conflicting arguments.

- Note: Consensus need not imply unanimity."

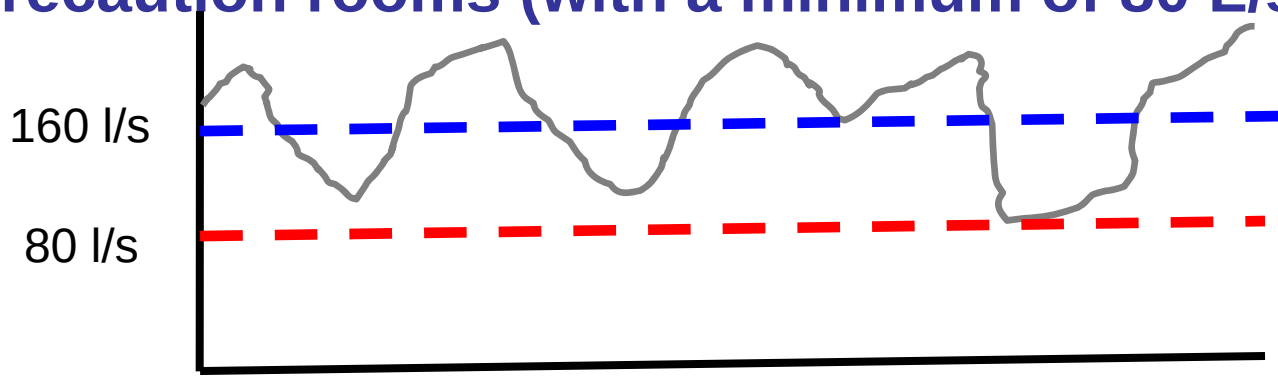
A slide from the meeting

Possible meeting rules?

- If you talk, 3 minutes each time. You can always start a new one.
- Two steps to reach consensus
  - The easy one – if no one object, it is done.
  - The difficult one – voting may not be a good idea…
- Of course, we can always leave those without a consensus there as well…
- Other suggestions
- Appoint two members to take notes….in addition to Xiaolei

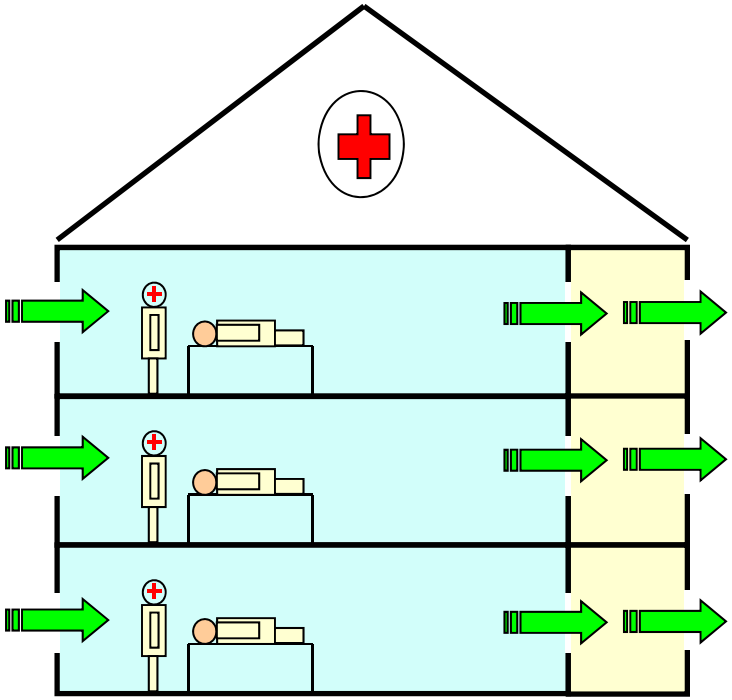
WHO 2009 NatVent Guideline – key ideas

- **For natural ventilation, a minimum hourly averaged ventilation rate of 160 L/s/patient for airborne precaution rooms (with a minimum of 80 L/s/patient).**

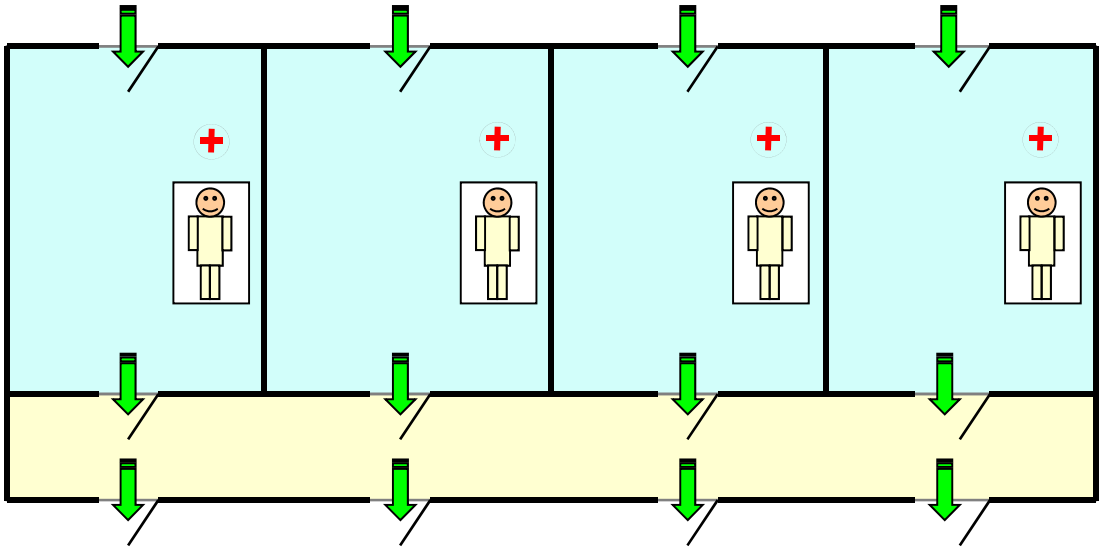


- When natural ventilation alone cannot satisfy the requirements, mechanically assisted natural ventilation system should be used.
- **Overall airflow should bring the air from the agent sources to areas where there is sufficient dilution, and preferably to the outdoors.**

One-side Corridor Type - Wind from ward to corridor

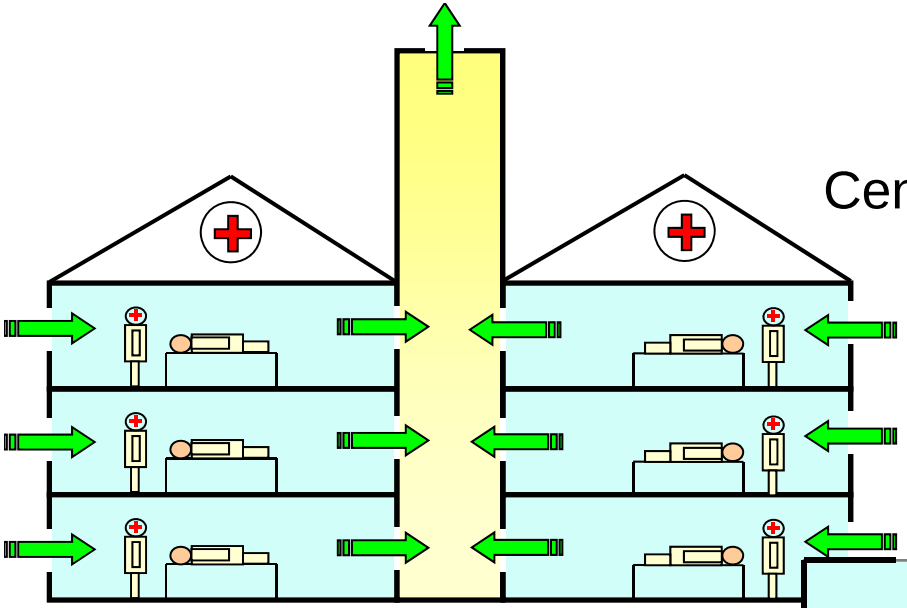


Section Plan



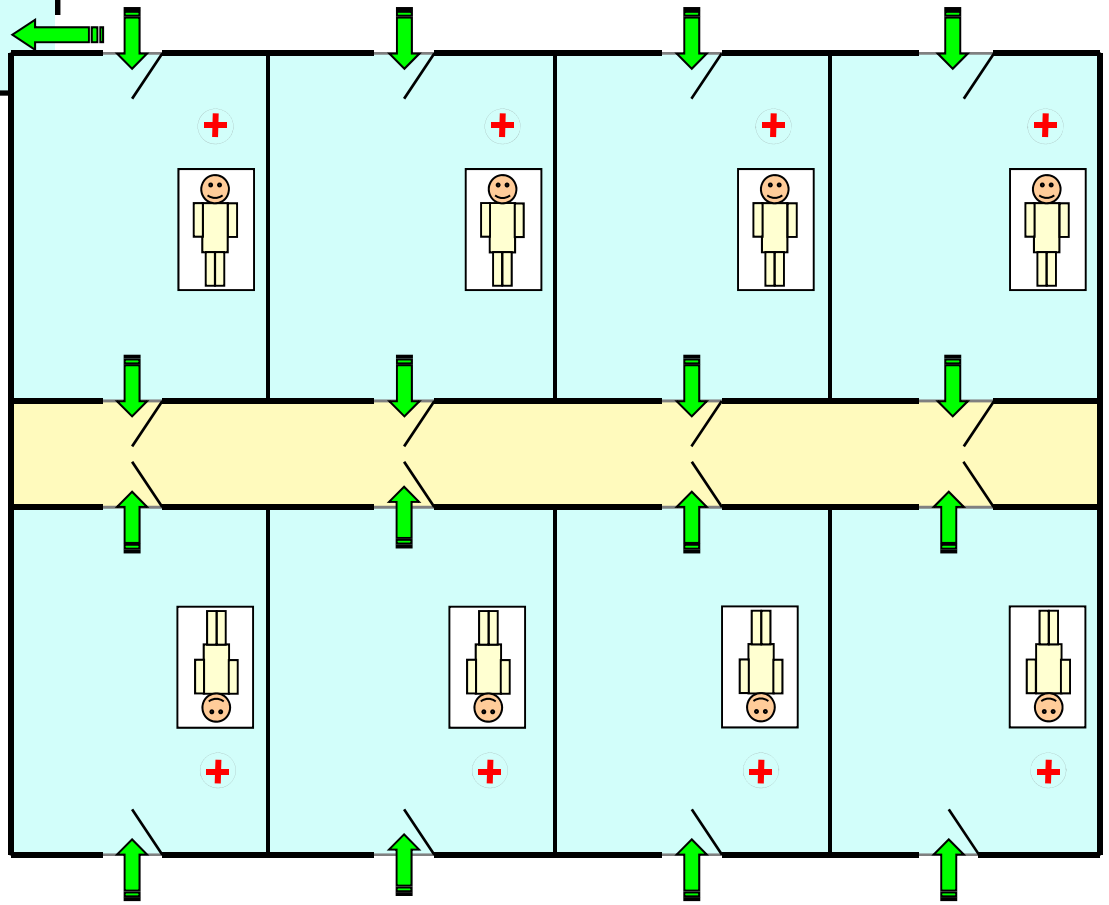
Floor Plan

Central Chimney type -Opposing Wind

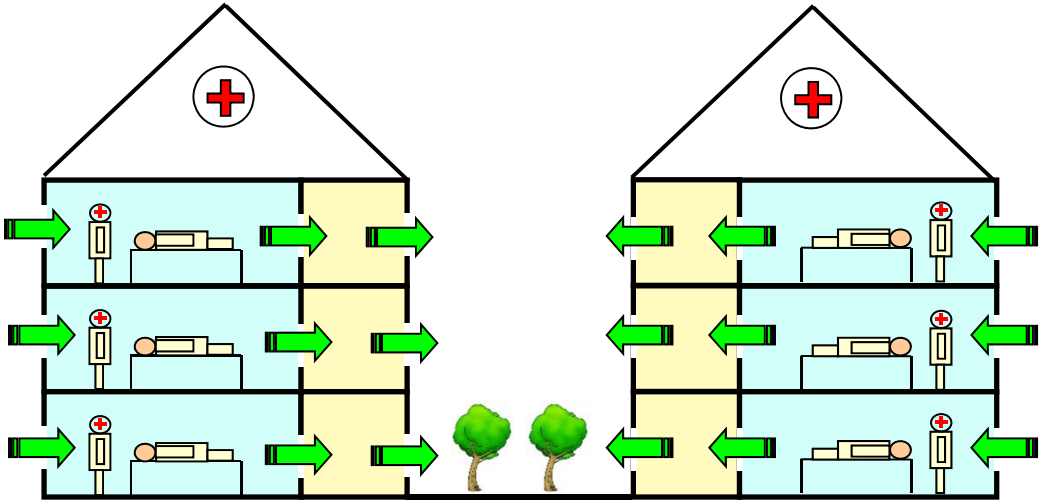


Section Plan

Floor Plan



Courtyard Type (Inner corridor) -Wind from ward to corridor to courtyard



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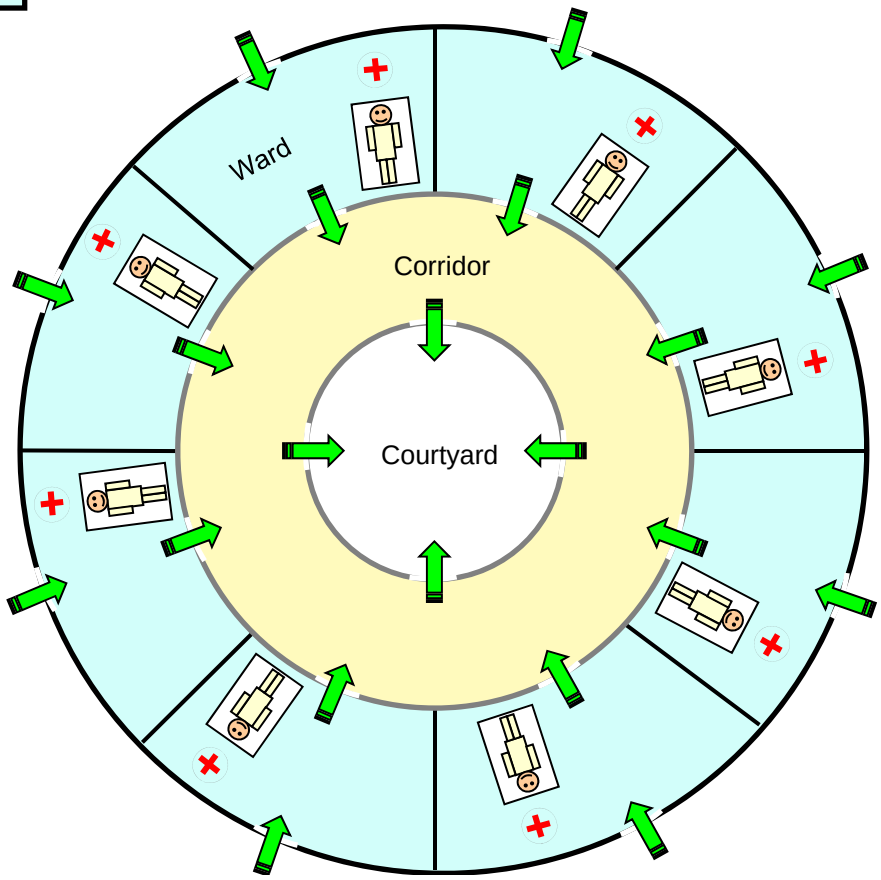


Even more difficult in the WHO meeting, but enjoyable

WHO publication/guidelines

Natural ventilation for infection control in health care settings

Geneva Final 30/06/09

A campaigner is your friend

Yves represented WHO in the meeting on May 6-10 2007, held at the Haking Wong Engineering Building at the University of Hong Kong.

When one of the team members cautioned "I think at the moment there is so much interest that we need to move cautiously to ensure that it does not get out of control. I should be OK for Tuesday but I suggest that for the time being we keep this group very small and work out some details first.". Yves replied: *"…I fully agree with you. What we are cooking may burn. We have to add the ingredients carefully and in an organized manner. This is why an outside view from our people here is good as it represents a very important supportive and constructive in-house critical mass.*"

Email dated 29 June 2007 by Yves

" …This week Carmem and myself had a meeting with our coordinators, a key person from TB, someone from occupational safety... to discuss our specific project.
There is a lot of enthusiasm from this group and we can count on their full support to back up this project.
We had interesting discussions and it was even decided to raise the initial budget higher up.
For your information, on top of the $ 25 000 provided by TB, the French government is given us 175 000 euros.
Meaning that in term of funds we are fine. We will try to get more to cover research or potential pilot projects.
While looking at the structure with the group it was felt that some part of chapters may be overlapping.
We will have another meeting with the same group next Tuesday.
We would like to discuss this urgently with you. Would you be available next week on Thursday July 5 or Friday July 6 to talk on the phone?
We will call you.
I can feel a very high dynamic (air flow speed) around this project and we better shape it right at the soonest. …"

A campaigner is your friend

- On May 12-17, I was in Geneva to finalize the guideline. Yves invited me and James to his home on Friday evening May 15.

- On 20 May 2009, Yves wrote to me: "*Yuguo, I am proud that the first French family you visited in France was mine. It will bring us luck. We can also be the second family you visit. Our house is open for you anytime*."

- Without Yves, this ground-breaking WHO guideline would not have been possible. I shall remember him as a great individual who sacrifice for the poor in the world, as a colleague who would try everything he could to make my job easier, as a friend who I can always trust, and his life has reminded me that we live to help others.

Training phase (2006-present)

- 2 training lectures per year for the last 6 years
- 1500 nurses and professionals attended
- For HK Infection Control Nurses' Association (associate member)

- Coordinated CHP 2007 training course

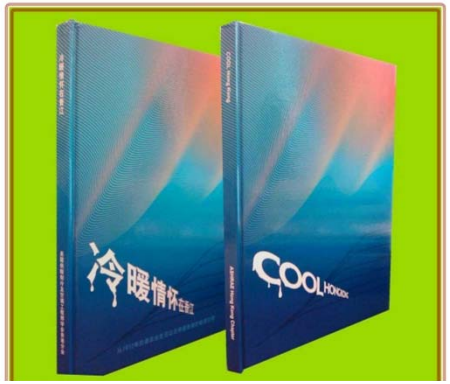
- WHO temporary advisor for Indonesian Ministry of Health – avian flu islation room in 20 hospitals

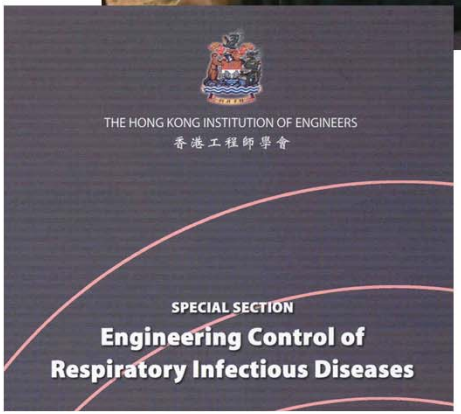
- Many talks in HK, Aus, US, Taiwan, Korea, Japan, China etc

- ASHRAE journal column on hospital ventilation

- HKIE Transaction special issue

- Cool Hong Kong author





Near future plan

- Regular talks continue
- Planning a new WHO workshop on natural ventilation in Hong Kong, supported by Hong Kong Infection Control Nurses Association.
- Revise WHO 2009 guideline
- ASHRAE magazine column article on negative pressure
- 2012 October Beijing TB conf invited talk
- ASHRAE EHC membership to develop research priority and new hospital ventilation design guidelines
- 2012 ASHRAE Distinguished lecturer in world chapters on the topic

IAQ APPLICATIONS

Figure 1 (left): The well-known "inversion clouds" phenomenon in the lower thermally stratified zone in a displacement ventilated room. Figure 2 (right): Smoke visualization of exhaled air stratifying due to entrainment of room air combined with a vertical temperature gradient 0.5°C/m (0.27°F/ft).[6]

Displacement Ventilation In Hospital Environments

By Yuguo Li, Ph.D., Fellow ASHRAE; Peter V. Nielsen, Ph.D., Fellow ASHRAE; Mats Sandberg, Ph.D.

ospitals differ from conventional buildings in terms of ventilation needs. How Displacement Ventilation Works

HONG KONG INFECTION CONTROL NURSES' ASSOCIATION

Dear Dr. Li,

Re : Certificate Course on Infection Control for Nurses – 2008

On behalf of the Hong Kong Infection Control Nurses' Association, I would like to thank you for agreeing to deliver a lecture to nurses enrolled for t he captioned course. I am writing to confirm the details as follows :-

Date	:	**October 20, 2008**
Time	:	**6:00 pm – 7:00 pm**
Topic	:	**Ventilation in Health care setting**
Venue	:	**Lecture hall, M/F, HAHO**

The WHO 2007 interim guideline has been developed just in time, which has been used in the WHO management of the 2009 H1N1 influenza pandemic and also in the avian flu epidemics in some parts of the world.

The second guidelines have just been published (October 2009), which will be of great help for the infection control of airborne infections in future, as we believe.

We shall be happy to provide further information if needed.

Yours sincerely,

IHEEM Hong Kong Branch | The Hong Kong Institution of Engineers Building Services Division | ASHRAE Hong Kong Chapter | CIBSE Hong Kong Branch

Technical Talk

Title	:	Control of airborne/droplet-borne infectious diseases in hospitals – where is engineering?
Date & Time	:	**28 March 2006 (Tuesday)** 5:45 p.m. to 6:00 pm Refreshment 6:00 p.m. to 7:00 p.m. Seminar
Venue	:	Basement Hall, Methodist Hall, 36 Hennessy Road, Wanchai, H.K.

KE – tips for getting some work done

- Getting help from successful practitioners
- Offer your help whenever you can
- Have a good story to tell
- Work with relevant professional societies
- Learn from my collaborators from another discipline and non-academic sector
- Do not be afraid of other disciplines
- Keep focused – getting one thing done at a time

KE – pitfalls to avoid

- Do not let others done (the coffee story)
- Perhaps other people may be more suitable for the job (PL Yuen and Indonesian project)
- Aim for the big goal, do not focus on the small differences between you and others
- There are experts in all fields

Thanks to our collaborators

•学生和合作者：Qian Hua, Xie Xiaojian, Hang Jian, Liu Li, Zhang Lei

•流行病学

Ignatious Yu, TW Wong, 香港中文大学医学院

Benjamin J Cowling, Gabriel Leung -香港大学流行病学

•微生物学

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