Infection control considerations for healthcare institutions in community setting

Building and Design
Infection control perspective

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ICB/CHP
DOCTOR

Architect

Different perspective

Infection Control  Building & design
Why infectious diseases?

- Individual
- Biological effect
- Infectious diseases
- Community
- Psychological effect
- Public health
- Fear
- Epidemic
- International level
- International emergency
- Pandemic
The dynamics of Infectious Diseases

- Host
- Vector
- Microorganisms
- Environment
Hierarchy of Infection control

Administrative
- Legislations
- Guidelines and policies
- Surveillance and reporting
- Vaccination program

Engineering
- Ventilation design
- Isolation rooms

Personal
- Mask
- Gowns
- Gloves
CDC 1996: 2 tier approach

Standard Precaution

+ 

Transmission based precaution

Contact  Droplet  Airborne
Droplet nuclei that can suspend in air over long distance (>1m)

TB, Measles, Chickenpox

Transmission of droplet nuclei at short range during special circumstances (Aerosol-generating procedures)

SARS Co-V, Influenza

Droplet nuclei generated that can propel a short distance (<1m)

Adenovirus, RSV, Influenza, SARS Co-V

Airborne

Opportunistic airborne
Environmental problems encountered in hospital

1. Crowding
2. Difficult to clean
3. Temperature and humidity
4. Pest control

Community healthcare institutes

1. Crowding
2. Difficult to clean (irregular surface)
3. Temperature and humidity
4. Pest control
MDRA菌非常「命硬」，在乾燥環境也能生存，專攻長期住院、需插喉駁呼吸機或尿管的病人，若病人於插喉期間將帶菌痰液吸入肺部，可併發肺炎，現時僅一種抗生素「多黏菌素」可殺該菌。
Inanimated objects in healthcare facilities

- High touch surfaces
- Porous surfaces
- Fixed decorations
香港大學李嘉誠醫學院微生物學系講座教授袁國勇：
「我地醫院感染控制有好大改善空間」
政好星期天
商業電台 21/6/2015
Example:
1. MRAB contaminates ventilation system
2. MRAB spread through air-conditioning system
3. An organism originally transmitted only by contact becomes droplet/airborne
Epidemiologically important acute respiratory tract infection originating from animals
a sneeze can generate 40000 droplets
Evaporate to produce droplets of 0.5-12 μm

95% droplet falls within 1m

Courtesy of Prof. Andrew Davidhazy
School of Photographic Arts and Sciences
Rochester Institute of Technology
A droplet fall from 3 meter

Virus: 0.02 – 0.3 um
Bacteria: 5 – 100 um
Fungal spore: 1 – 10 um

Size

small

1 um
10 um
20 um
100 um

big

10 sec min
4 min
17 min

Suspend in air
Prevention of spread of infection transmitted by droplet

Promotes transmission by close contact/droplet
Also results in:
1. Poor ventilation
2. High temperature
3. Increase in humidity

Overcrowding

Dilution: Air change per hour
Air quality: Filtration
Direction of air flow: air change, pressure difference

Ventilation
Aspergillosis

A result of mould in the environment

Cause lung infection

Rotten lungs and cavity formation
Factors required for Mould to grow

- **Humidity**: 70%
- **Temperature**: 25°C
- **Low level of light**
- **Organic materials**

Carbon: 12.011
Airborne infection

Tuberculosis
Measles
Chichenpox
Grantham hospital

Located on the hill top
Used to host TB patients
Large windows
<table>
<thead>
<tr>
<th>Test</th>
<th>Date</th>
<th>Ward</th>
<th>Windows /doors to outdoor (%) open</th>
<th>Door to corridor (%) open</th>
<th>Fan</th>
<th>Room type</th>
<th>ACH</th>
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<tbody>
<tr>
<td>1</td>
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<td>2 beds</td>
<td>30.3</td>
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<td>2</td>
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<td>100</td>
<td>off</td>
<td>2 beds</td>
<td>17.6</td>
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<td>off</td>
<td>2 beds</td>
<td>14.6</td>
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</tr>
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<td>2 beds</td>
<td>42.2</td>
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</tr>
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<tr>
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<td>29.2</td>
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</table>

ACH, air changes per hour.

* The window air-conditioner was on in the ward during the experiment.

* Tests 8 and 11: the ventilation rates were so high that the sampled data were inadequate.
## Air change per hour

<table>
<thead>
<tr>
<th>ACH</th>
<th>Time required for removal efficiency of 99% (min)</th>
<th>Time required for removal efficiency of 99.9% (min)</th>
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<tr>
<td>50</td>
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</table>
Factors affecting Leginoella infection

Reservoir

Contamination

Condition (Temperature range 20-45°C, biofilm, stagnation)

Dissemination

Host
BCYE + Ferric pyrophosphate + L-cysteine + minerals/vitamins
We have all the guidelines available

What is happening?
Green Hospital Features

Natural ventilation
(lack cross vent windows, high ceiling, long redundant corridors)

Sea breeze

Low level of lighting (automatic sensor)

Indoor temperature $\sim 25-25.5^\circ C$

Indoor garden

Low water pressure
Residing in the environment

Contacting human

Active removal

Temperature, humidity, lighting
Better planning and design
Physical separation
Ventilation
Design to ensure easy cleansing
製藥雖無人見存心，
自有天知。見存心自有天知香。
為之而善小而不為，
賢惟德可以服人也。
原文為積德雖無人
見存心自有天知香。
港名藥廠以此對掛於門前以此告誡後人
又云人在做天在看君子慎獨勿以惡小而