Establishing an Infection Control Program for Acute Respiratory Infections
Prof. Wing Hong Seto, Queen Mary Hospital, Hong Kong
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The problem of over reaction on the wrong thing

WHO PPP Tools
(Global Pandemic Plan + Checklist)

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Contents
• Introduction
• Infection prevention and control recommendations
• Environmental ventilation for respiratory infections
• Preparedness planning for ARD epidemics
• Annexes

Key Features:
1. Standard precautions with cough etiquette
2. ARD of public health emergency and international concern: SARS, new influenza virus, novel ARD
3. Measures before diagnosis is made (Figure 1)
4. Cohort patients or if not separation by 1m apart
5. Special measures for pediatric patients
6. Measures after diagnosis is made (Table 1)
7. Handling high risk procedures
8. Isolation rooms and when it is no enough
9. Use of PPEs and managing surge capacity
10. Infection Control in special situations

Modes of transmission

<table>
<thead>
<tr>
<th>General</th>
<th>Specific – isolation rooms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airborne</td>
<td>• Barrier precautions when needed</td>
</tr>
<tr>
<td></td>
<td>• Meticulous hand hygiene</td>
</tr>
<tr>
<td>Contact</td>
<td>• Good environmental hygiene</td>
</tr>
<tr>
<td>Bloodborne</td>
<td>Preventive of needle stick</td>
</tr>
</tbody>
</table>

Table 4: Standard Precautions in all Healthcare Settings

Hand Hygiene
- Good surgical masks – 3'
Gowning & gloves on contact
Prevention of needle stick

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Definitions

- Acute respiratory diseases (ARD)
  - Infective causes
- Acute respiratory disease of potential concern
  - ARD with public impact
  - International Health Regulation (2005)
    • SARS
    • New influenza subtype
    • New organisms causing large-scale outbreaks and outbreaks with high morbidity and mortality
    • Plague

Bacteria That Cause Airborne Nosocomial Infections

- Group A Streptococcus
- Staph. aureus
- Neisseria meningitidis
- Bordetella pertussis
- MTB
- Nocardia

Viruses Implicated in Airborne Nosocomial Infections

- Rino viruses
- Influenza and
  - Parainfluenza viruses
- Respiratory Syncytial Virus
- Adenovirus
- Variella Zoster Virus
- Measles
- Rubella
- Smallpox
- Certain enteroviruses

Adapted from Schaal, 1985

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Transmission Based Precaution

<table>
<thead>
<tr>
<th>Transmission Type</th>
<th>Pathogen(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airborne</td>
<td>Pulm. TB, Measles, Varicella Zoster</td>
</tr>
<tr>
<td>Droplet</td>
<td>Influenza, Meningococcal, Pertussis</td>
</tr>
<tr>
<td>Contact</td>
<td>MR organisms, Enteric RSV</td>
</tr>
<tr>
<td>Blood</td>
<td>Exposure to blood inoculation</td>
</tr>
</tbody>
</table>

Is Influenza Airborne?

“Transmission of influenza A in human beings”

Search of 2012 citations

“Is Influenza Airborne?”

Artificial aerosol can infect man and animals

Artificial aerosols: <10% are larger 8 µm
Natural coughing: 99.9% are larger then 8 µm

“We question whether these studies are relevant to natural route of human transmission”

“No published evidence of human infection resulting from the ambient air”

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Recent classification for airborne transmission

Obligate airborne: initiate solely through aerosols: TB

Preferential airborne: initiate through multiple routes but predominately by aerosols: Chicken pox and measles

Opportunistic airborne: typically through other routes but by aerosols in favorable conditions (as high-risk procedures such as intubation): Influenza and SARS

Table 1. The scope and definitions of three transmission models

<table>
<thead>
<tr>
<th>Mode of transmission</th>
<th>Definition</th>
<th>Examples of the agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airborne</td>
<td>Transmission of disease caused by dissemination of droplet nuclei that remain infectious when suspended in air over long distance (&gt;1 m) and time. Airborne transmission can be further categorized into obligate or preferential airborne transmission. <em>Obligate airborne</em> transmission refers to pathogens that are transmitted only by deposition of droplet nuclei under natural conditions. <em>Preferential airborne</em> transmission refers to pathogens that can initiate infection by multiple routes, but are predominantly transmitted by droplet nuclei.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>pulmonary tuberculosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mode of transmission</th>
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<th>Examples of the agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Droplet</td>
<td>Transmission of droplet nuclei at short range during special circumstances, such as the performance of aerosol-generating procedures associated with pathogen transmission.</td>
<td></td>
</tr>
</tbody>
</table>

Obligate airborne

Transmission of droplet nuclei at short range during special circumstances, such as the performance of aerosol-generating procedures associated with pathogen transmission.

Obligate airborne

Transmission of droplet nuclei at short range during special circumstances, such as the performance of aerosol-generating procedures associated with pathogen transmission, initiated solely through aerosols: TB

Preferential airborne

Transmission of droplet nuclei at short range during special circumstances, such as the performance of aerosol-generating procedures associated with pathogen transmission, initiated through multiple routes but predominantly by aerosols: Chicken pox and measles

Opportunistic airborne

Transmission of droplet nuclei at short range during special circumstances, such as the performance of aerosol-generating procedures associated with pathogen transmission, typically through other routes but by aerosols in favorable conditions (as high-risk procedures such as intubation): Influenza and SARS

WHO systemic review - 2008

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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>pulmonary tuberculosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Research letters

Is SARS airborne?

3 Effectiveness of precautions against droplets and contact in prevention of nosocomial transmission of severe acute respiratory syndrome (SARS)

A.Y. Seto, T. Tang, Y.K. Kong, T.Y. Ching, T.Y. Ng, P.H. Lam, S.M. Ho, and Members of Expert SARS Group of Hospital Authority

We did not identify any method used in the Hong Kong hospitals, with 642 inpatients and 158 healthcare workers, to break the transmission of SARS-CoV which matched our methods. Therefore, we changed our method and introduced four precautionary measures to break the transmission:

1. Personal protection by healthcare workers
2. Handwashing after patient contact
3. Use chrysalis or gloves when touching patient's droplets
4. Use chrysalis, gloves, and gowns when performing aerosol-generating procedures

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4. Use chrysalis, gloves, and gowns when performing aerosol-generating procedures

Next, we also compared the efficacy of these measures with those in the Hong Kong hospitals. The results suggested that in hospitals, effective transmission by droplets is significantly reduced by the use of personal protection measures. This suggests that the use of personal protection measures is crucial in the prevention of nosocomial transmission of SARS-CoV.

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No studies to date have demonstrated human infection occurring from naturally aerosolized influenza or human infection occurring by inhalation of artificially aerosolized influenza in ambient rather then directed air.

Finally a recent study focused on air sampling in a busy hospital emergency room during influenza’s seasonal activity ….. detected in the air fraction was in small particles 1 to 4 micrometers in size. PCR detection, rather then viral culture and assessment of viability, was utilized in this study, so the significance of these findings needs further investigation.

Healthcare Infection Control Practices Advisory Committee (HICPAC)

“confirm the presence of airborne influenza virus in various clinic locations”

Page 17: “confirm the presence of airborne influenza virus in various clinic locations”

But there is a study not considered by IOM showing that surgical masks is as effective as N95.

Surgical Mask vs N95 Respirator for Preventing Influenza Among Health Care Workers: A Randomized Trial.
Mark Loeb et al, JAMA, 2009;302(17), October 1 online

A randomized controlled trial of 446 nurses in 8 tertiary care hospitals – Ontario

<table>
<thead>
<tr>
<th>Surgical masks</th>
<th>N95</th>
</tr>
</thead>
<tbody>
<tr>
<td>n =</td>
<td>225</td>
</tr>
<tr>
<td>Influenza infected =</td>
<td>50 (23.6%)</td>
</tr>
<tr>
<td>p = 0.086 (meet criteria for non-inferiority)</td>
<td></td>
</tr>
</tbody>
</table>

But Macintyre group retracted their study

November 3, 2009

President Barack Obama
The White House
1600 Pennsylvania Avenue, NW
Washington, D.C. 20500

Dear President Obama:

During this time of national emergency due to the 2009 H1N1 influenza pandemic, it is imperative that healthcare professionals and facilities receive clear, practical, and evidence-based federal guidance to ensure patient and healthcare worker safety. With this in mind, the Society for Healthcare Epidemiology of America (SHEA), Infection Disease Society of America (IDSA), and Association of Professionals in Infection Control and Epidemiology (APIC) urge you to engage significant counsel with the scientific guidance developed by your Administration in consultation with several experts and recently created the Council for Decline Control and Prevention (CDC), and Occupational Safety and Health Administration (OSHA) requirements concerning the use of personal protective equipment (PPE) for healthcare workers in treating confirmed or suspected cases of H1N1 infection.

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CDC change in June 2010.
“In a change from previous pandemic H1N1 recommendations, the CDC advises that healthcare workers wear face masks [ie. the surgical masks] when entering the room of a patient who has confirmed or suspected flu. Earlier recommendations suggested that staff wear N-95 respirators during all contact with flu patients; however, the new guidance recommends N-95s or higher levels of protection during risky procedures such as aerosol-generating procedures.”

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Implementation of WHO ARD guideline

- **AED**
  - Facilities required:
    - Medical/surgical masks
    - Alcohol hand rub
    - Tissue papers
    - Segregation of ILIs

- **General medical units**
  - Facilities required:
    - ARD cubicles (beds separated by 1 m apart, with no extra/camp beds)
    - Sufficient supply of PPEs
    - Hand hygiene facilities (alcohol hand rub, sinks, etc.)
    - Suction for NPA (viral TM)

Flowchart for implementation of WHO ARD guideline in AED

- Patient registration with freely provided medical mask and alcohol hand rub
  - Triage
  - Assess if AED
  - No
    - Lines of another illnesses
    - Give medical mask + Alcohol hand rub
  - Direct to segregated area
  - Assessed by AED doctors

Flowchart for using ARD in Medicine

- AED diagnosis of MERS, influenza, H1N1
  - If confirmed, respiratory virus, optimize for source + contact isolation & CICU
  - Practice droplet, contact and standard precautions
  - Sputum, swab
  - Test
  - Isolation
  - Use PPEs
  - Disposition
  - Direct to segregated area
  - Assess by AED doctors
  - Contact isolation + adequate of compliance to be exchanged

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COPDs

1. Diagnosis of exacerbation can be made in at least about 70% of the time
2. Most are due to bacteria
3. Viral may account for about 10%
4. They usually have added features like coryza, sore-throat, myalgia, joint pains, high fever.
5. NPA should not be routinely done but only when indicated.

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Special droplet precautions for Pediatric Patients
1. Beds are 1m apart
2. Patients are not to leave bed without permission
3. No sharing of non-essential medical equipments
4. Patient records are not placed by the bedside
5. No common play area
6. Once diagnosis made, relevant isolations may be needed

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Visitor’s policy

• 3 visitors named on admission
  – Only 1 visitor at bedside at any one time
  – 24 hour visit allowed
  – Visitors gown and mask

Clinical and epidemiological clues

• Clinical clues
  – Unexplained severe acute febrile respiratory illness
  – Unexplained illnesses
  – Exposure history within incubation period

• Epidemiological clues
  – Travel history
  – Occupation
  – Contact
  – Cluster

Note sensor for door and alcohol rub.

Nurses station is a clean zone. Medical charts stay here. No gowns or gloves allowed. Mask not really needed if not going in to see patients.
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Fix the procedures (pp22)
For all ARDs
- Coughing refers to placing patients infected or colonised with the same pathogens in the same designated unit (same space and staff as the unit). Wherever possible, cohorting should be used for implementation of isolation precautions where single room care is not available (63).
- If the epidemiological diagnosis is not laboratory-confirmed, cohorting, as described above, is not possible. Because of the transmissibility of patients, it should be limited in single rooms, whenever possible.
- Resuscitation of patients with respiratory infections should be performed at a distance of at least 1 m from one another.
- Avoid sharing of personal protective equipment and wearing of face masks. (65), and adequate hand hygiene by patients, visitors and caregivers (67, 68).“In Paediatric patients with ARDs….Contact, Standard and Droplet Precautions should be implemented whenever possible.” pp11

Table 1: Infection control precautions for ICUs and caregivers providing care for patients with ARDs according to a 5 step algorithm

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PPEs (Yes)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Gowns (No)</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No (Fabric)</td>
</tr>
<tr>
<td>Cap (No)</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No (Fabric)</td>
</tr>
<tr>
<td>Standard and Droplet</td>
<td>No (Fabric)</td>
<td>Yes (Fabric)</td>
<td>Yes (Fabric)</td>
<td>Yes (Fabric)</td>
<td>Yes (Fabric)</td>
<td>Yes (Fabric)</td>
</tr>
<tr>
<td>Hand hygiene:</td>
<td>Yes (Fabric)</td>
<td>Yes (Fabric)</td>
<td>Yes (Fabric)</td>
<td>Yes (Fabric)</td>
<td>Yes (Fabric)</td>
<td>Yes (Fabric)</td>
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Flowchart for using ARD in Medicine
ARD diagnosis of SARS, influenza A(H3N2), hospitalisation in Intensive Care (ICU) and in Endoscopy (ERCP) or radiology (x-ray)

Allocate the patient to ARD-CIRCULAR

If indicated, NPIs for respiratory viruses - patients for surgery (in hospital ward & ICU)

Practice: droplet, contact and standard precautions

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Aerosol-generating procedures

1. PPE
   - Gown
   - N95 and eye protection
   - Gloves

2. Ventilation
   - 6-12 ACH

3. Hand hygiene

WHO guideline

1.1. When performing aerosol-generating procedures associated with an increased risk of infection transmission (e.g., aspiration or open suctioning of the respiratory tract), including for the collection of lower respiratory tract specimens, intubation, resuscitation, bronchoscopy, autopsies, etc., IPC precautions should include the following:
   - Use a particulate respirator (e.g., FFP2, N95) for breathing, eye protection (e.g., goggles or a face shield), a clean, non-sterile, long-sleeved gown, and gloves (some of these procedures require sterile gloves).
   - Perform procedures in an adequately ventilated room, e.g., minimum of 6 to 12 air changes per hour in facilities with a mechanically ventilated room and at least 25 filters/second/patient in facilities with natural ventilation.
   - Limit individuals in the room only to those required for the patient’s care and support.
   - Perform hand hygiene before and after patient contact and after PPE removal.
   - Non-invasive ventilation (NIV) (i.e., BIPAP, CPAP) unless indicated otherwise by new evidence of increased transmission risk.
   - Nebulization: Standard and Droplet Precautions. Nebulizer treatment should be performed in an area that is physically separated from other patients (e.g., treatment room, screened enclosure).

Aerosol-generating high risk procedures

Both WHO/CDC: Intubation, bronchoscopy, autopsies, cardiopulmonary resuscitation, open suction of airways. CDC only: extubation, sputum induction;
WHO only: collection of lower respiratory tract specimens.

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About Sputum Induction
Sputum induction is used to obtain sputum for diagnostic purposes when patients are unable to spontaneously expectorate a specimen. The procedure uses sterile water or hypertonic saline to irritate the airway, increase secretions, promote coughing, and produce a specimen. The CDC and OSHA both classify sputum induction as a high-risk procedure when performed on a person with suspected or known infectious TB.

WHO guideline
1. When performing aerosol-generating procedures associated with an increased risk of infection transmission (e.g., aspiration or open suctioning of the respiratory tract, including for the collection of lower respiratory tract specimens; intubation, resuscitation, bronchoscopy, autopsy, etc.), IPC precautions should include the following:
   a. Wear a particulate respirator (e.g., N95, see for listing); eye protection (i.e., goggles or a face shield); a clean, non-stereile, long-sleeved gown, and gloves (some of these procedures require sterile gloves).
   b. Perform procedures in an adequately ventilated room; e.g., minimum of 6 to 12 air changes per hour in facilities with a mechanically ventilated room and at least 6 liters/second/patient in facilities with natural ventilation.
   c. Limit individuals in the room only to those required for the patient’s care and support.
   d. Perform hand hygiene before and after patient contact and before PPE removal.
   e. Non-invasive ventilation (NIV) (i.e., BiPAP, CPAP).

Nebulizers
Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 10, No. 2, February 2004

Cluster of SARS among Medical Students Exposed to Single Patient, Hong Kong
Tammie Wing, Chinnok Lee, N. Wilson Tan, Joseph S. Brown, Joseph J.Y. Sung, and Ummesh D. Parakh for the Outbreak Study Group

At the time this investigation was begun, jet nebulizer therapy given to the index patient was widely believed to have facilitated transmission. However, our findings demonstrate efficient transmission even before nebulizer therapy was begun on the afternoon of March 6.

Table 3. Time schedule of the clinical assessment of 12 medical students

<table>
<thead>
<tr>
<th>Time</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 March 2003</td>
<td>10:30 a.m.</td>
<td>10:30 a.m.</td>
</tr>
<tr>
<td>5:30-6:45 a.m.</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>10:30-11:30 a.m.</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>12:00-2:00 p.m.</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>5 March 2003</td>
<td>11:30 a.m.</td>
<td>11:30 a.m.</td>
</tr>
<tr>
<td>10:30-11:15 a.m.</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>12:00-2:00 p.m.</td>
<td>0.9</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Excluding the index patient whose disease lasted long after the outbreak.

Lastly, for the students with SARS who were present on the ward for reasons other than the bedside assessment, no association was observed between their stay in the ward at the specific periods when the nebulizer was used and the development of SARS.

A Large-Volume Nebulizer Would Not Be an Infectious Source for Severe Acute Respiratory Syndrome
Guo-Hua Wan, PhD, Ying-Hung Tasi, MD, Yau-Kuang Wu, MD, Kuo-Chen Tsau, MSc

ABSTRACT
We attempted to detect the presence of airborne SARS-coronavirus (COV) in a healthcare setting when a patient with SARS was ventilated in a large-volume nebulizer (LUN). All of the COV samples from the LUN and UV were found to have neutralizing antibodies to SARS virus products (Infectious Respiratory Evid Res 2002;12:1151-1153).

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NIVs

We defined a superspreading event as the development of 3 new cases of SARS in a ward during the period from 2 to 10 days.

Some exposures were of ecological nature (applying similarly to all patients in the ward at a given time), thus making it impossible to be sure that a given patient was really exposed to the risk factor under consideration.

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9. Use of PPEs and managing surge capacity
10. Infection Control in special situations

Special situations

1. Care of the diseased (pp 31)
2. Environmental cleaning and disinfection (pp 55)
3. Cleaning and disinfection of respiratory equipments (pp 74)
4. Waste management (pp 56)
5. Needle stick injury prevention (pp 57)
6. Infection control across continuum of care (pp 76)
7. Respiratory protection (pp 44)
   Important of seal check every time
   Stated that fit test does not have evidence

Key Features:

1. Standard precautions with cough etiquette
2. ARD of public health emergency and international concern: SARS, new influenza virus, novel ARD
3. Measures before diagnosis is made (Figure 1)
4. Cohort patients or if not separation by 1m apart
5. Special measures for pediatric patients
6. Measures after diagnosis is made (Table 1)
7. Handling high risk procedures
8. Isolation rooms and when it is no enough
9. Use of PPEs and managing surge capacity
10. Infection Control in special situations

Airborne transmission isolation room:
• Single room or cohorting
• Negative pressure (-2.5 Pa)
• 12 air changes per hour for new renovations
• Exhaust air outside or recirculated HEPA filters

Graphs constructed by Wells-Riley equation to express the relationship between infection risk over ventilation rate, quanta generation rate and exposure time.

Measurements in Grantham Chest Hospital Hong Kong (tests in 4 rooms)
- Windows open: 50% = 15.5 ACH
- Windows open: 100% = 45.4 ACH
- Windows closed: 50% = 20.2 ACH
- Windows closed: 100% = 3.4 ACH

A Webber Training Teleclass
Hosted by Philip Russo, Hand Hygiene Australia
www.webbertraining.com
Establishing an Infection Control Program for Acute Respiratory Infections
Prof. Wing Hong Seto, Queen Mary Hospital, Hong Kong
Sponsored by WHO Clean Care is Safer Care (www.who.int/gpsc/en)

Journal of TB and Lung Diseases; Oct 2005

AR Escombe et al: Supervise by Imperial College and John Hopkins
65 rooms in 8 hospitals in Lima, Peru
Old Facilities: Median 37 ACH
Modern Facilities: Median 18 ACH

TB incidence in Grantham and HA hospitals 1996-2005
Mean Incidence (per 100,000 pat year)
HA hospitals: (257 cases) 60.4
GH: (5 cases) 65.2
p = 0.9

Comparison of Non-clinical and Clinical Staff Infected by pH1N1

<table>
<thead>
<tr>
<th></th>
<th>Non-clinical</th>
<th>Clinical</th>
<th>Statistical significance (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of staff (n)</td>
<td>18759</td>
<td>40511</td>
<td></td>
</tr>
<tr>
<td>Number infected</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. During mandatory reporting for all staff</td>
<td>119 (0.63%)</td>
<td>249 (0.62%)</td>
<td>0.82 RR: 0.98 (95% CI 0.78-1.2)</td>
</tr>
<tr>
<td>B. Data during the entire pandemic period</td>
<td>NA</td>
<td>1039 (2.6%)</td>
<td></td>
</tr>
<tr>
<td>For Infected staff (n)</td>
<td>119</td>
<td>1039</td>
<td></td>
</tr>
<tr>
<td>Demographic data</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>36 (30.3%)</td>
<td>253 (24.4%)</td>
<td>0.19 HK – 3.6% for same age group (Cowling et al – accepted CID)</td>
</tr>
<tr>
<td>F</td>
<td>83 (70%)</td>
<td>786 (75.6%)</td>
<td></td>
</tr>
<tr>
<td>Mean age</td>
<td>38.6</td>
<td>37</td>
<td>0.45</td>
</tr>
</tbody>
</table>

A study comparing clinical and non-clinical staff under the condition of mandatory reporting

Seto et al: CID (in press)

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www.webbertraining.com
Dr. Seto,

I really enjoyed your insightful presentation yesterday... I am sorry you had to skip through so many of the slides in the interests of time.

I did my infectious disease training in Australia at Fairfield hospital... a stand-alone infectious diseases hospital that saw/treated most of the TB patients in Victoria-- we had single rooms, all of which opened up to a private balcony... we used lots of open air ventilation, high ACH and none of our staff converted their TSTs.