The Mask in Infection Control – Understanding the Issues for Appropriate Practice
Prof. W.H. Seto, Hong Kong
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Definition of PPE

Any device or appliance designed to be worn or held by an individual for protection against one or more health and safety hazards

Rationale of PPE usage

- Risk assessment
- Level of resources
- Early confirmation of diagnosis

Limitations of PPE

- Short term protection
- Protect only the individuals with PPE
- Burden to users
- Need supervision, training and maintenance
- High running costs
- Not 100% guaranteed protection

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Modes of transmission

<table>
<thead>
<tr>
<th>General</th>
<th>Specific – isolation rooms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Airborne</strong></td>
<td>Nuclei of &lt; 5µm</td>
</tr>
<tr>
<td><strong>Droplets</strong></td>
<td>Nuclei of &gt; 5µm</td>
</tr>
<tr>
<td><strong>Contact</strong></td>
<td>Transmission by direct or indirect contact</td>
</tr>
<tr>
<td><strong>Bloodborne</strong></td>
<td>Prevention of needle stick</td>
</tr>
</tbody>
</table>

Standard Precautions

- Barriers
- Meticulous hand hygiene
- Good environmental hygiene

Transmission Based Precaution

<table>
<thead>
<tr>
<th>Airborne</th>
<th>Nuclei of &lt; 5µm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulm. TB</td>
<td></td>
</tr>
<tr>
<td>Measles</td>
<td></td>
</tr>
<tr>
<td>VZV</td>
<td></td>
</tr>
<tr>
<td>Influenza</td>
<td></td>
</tr>
<tr>
<td>Meningococcal Pertussis</td>
<td></td>
</tr>
<tr>
<td>SARS</td>
<td></td>
</tr>
<tr>
<td>MR organisms</td>
<td></td>
</tr>
<tr>
<td>Enteric RSV</td>
<td></td>
</tr>
<tr>
<td>SARS</td>
<td></td>
</tr>
</tbody>
</table>

Transmission of influenza A in human beings

Brankston et al., Lancet ID 2007(7):257-65

"We are able to conclude that transmission occurs at close range rather than over long distance, suggesting that airborne transmission, traditional defined, is unlikely to be of significance in most clinical setting."

Search of 2012 citations

Influenza and Enteric RSV

Bacteria That Cause Airborne Nosocomial Infections

- Group A Streptococcus
- Staph. aureus
- Neisseria meningitidis
- Bordetella pertussis
- MTB
- Acinetobacter
- Legionellae
- Clostridiae
- Pseudomonas
- Nocardiae

Viruses Implicated in Airborne Nosocomial Infections

- Rovinoviruses
- Influenza and
- Parainfluenza viruses
- Respiratory Syncytial Virus
- Adenovirus
- V冢ella Zoster Virus
- Measles
- Rebbelia
- Smallpox
- Certain enteroviruses

Adapted from Schaal, 1985

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Normal alveolar
Pneumonia

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;1m) and time. Airborne transmission can be further categorized into obligate or preferential airborne transmission.</td>
<td>pulmonary tuberculosis, measles, chickenpox</td>
</tr>
</tbody>
</table>

WHO systemic review - 2008

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Opportunistic airborne

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

Droplet

| Droplets are generated from an infected (source) person primarily during coughing, sneezing, and talking. Transmission occurs when these droplets containing microorganisms are propelled a short distance (usually ≤ 1 m) through the air and deposited on the conjunctiva, mouth, nasal, throat or pharynx mucosa of another person. | Adenovirus
| Respiratory Syncytial Virus
| Influenza
| SARS CoV |

WHO – 29th April 2009

“Human-to-human transmission of the pandemic (H1N1) 2009 virus appears to be primarily through droplets.”

What isolation precautions is needed for nH1N1?

Table 1: Infection control precautions for HCWs and caregivers providing care for patients with ARDs according to a category of pathogen.

<table>
<thead>
<tr>
<th>Precaution</th>
<th>Norovirus</th>
<th>Adenovirus</th>
<th>Rotavirus</th>
<th>SARS-CoV</th>
<th>Swine influenza A (H1N1)</th>
<th>Varicella zoster virus</th>
<th>Poliomyelitis</th>
<th>Clostridium difficile</th>
<th>Bacillus anthracis</th>
<th>Staphylococcus aureus</th>
<th>Methicillin-resistant Staphylococcus aureus</th>
<th>Health-care-associated Gram-negative bacilli</th>
<th>Enterococcus spp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Contact</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Droplet</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Airborne</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Photogenic Transmission</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

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The USA position

SHEA recommendations (10th June 2009)

Mode of transmission

"Available data and clinical experiences suggest that H1N1 transmission occurs like seasonal influenza via droplets spread".

"SHEA endorses implementing the same practices recommended to prevent the transmission of seasonal influenza for the novel H1N1".

Isolation Measures:

"Negative pressure rooms are not needed for the routine care of such patients. " "The N95 is not recommended as part of standard precautions". This applies even for "preventing seasonal influenza transmission."  

High risk aerosol-generating procedures:

Enhance respiratory protection including the N95 is recommended for such procedures. The procedures should include

- open suctioning of airway secretions,
- resuscitation involving emergency incubation or cardiac pulmonary resuscitation and endotracheal intubation"

However the following should not be included:

- collection of nasopharyngeal specimens,
- close suctioning of airway secretions and administration of nebulized medications"

CDC (13th May)


"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."

- confirm the presence of airborne influenza virus in various clinic locations


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.

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CDC website
HICPIC advisory committee
23rd July to vote on the latest recommendation

Endorse use of surgical masks for the routine care of patients with confirmed or suspected, novel influenza A (H1N1)⁴

It is appropriate at this time to recommend the use of N95 or higher respiratory protection for procedures that are likely to generate small particle aerosols. The procedures are then listed to include bronchoscopy, intubation under controlled or emergent situations, cardiopulmonary resuscitation, open airway suctioning and airway induction.

Comment on Blachere et al: PCR positive is not the same as culture positive

Aerosol generating procedures
SHEA
open suctioning of airway secretions, resuscitation involving emergency incubation cardiopulmonary resuscitation endotracheal intubation⁴

CDC HICPIC bronchoscopy, intubation under controlled or emergent situations, cardiopulmonary resuscitation, open airway suctioning and airway induction

WHO ARD
Intubation
Cardiopulmonary resuscitation + manual ventilation suction
Bronchoscopy
Autopsy/surgery

1st September 2009
Institute of Medicine
• HCWs (including non-hospital settings) in close contact with individuals with nH1N1 or ILIs should use fit-tested N95 respirators.
• Endorse current CDC guidelines.

Page 17: “confirm the presence of airborne influenza virus in various clinic locations”
Also based on the Macinthyre study done in China

Medical
Masks Gloves Gowns Eye Protection N95

Droplets
all cases Yes - - - -

Standard Precautions Yes Yes Yes Yes -

Aerosol Generating Yes Yes Yes Yes Yes

Resp swabs Yes Yes Yes Yes -

Collecting blood Yes Yes - - -

CDC (13th May)
Standard & Contact - Yes Yes Yes Yes

Enter Isolation room - all HCWs Yes

November 1, 2009
Dear President Obama:

During this time of national emergency due to the H1N1 (H1N1) influenza pandemic, it is imperative that healthcare professionals and facilities ensure they are properly prepared to ensure patient and healthcare worker safety. With this in mind, the Society for Healthcare Epidemiology of America (SHEA), Infectious Disease Society of America (IDSA), and the Association of Professionals in Infection Control and Epidemiology (APIC) urge the government to support the implementation of the CDC’s recommendations as proposed to help addresses the spread of the virus.

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

November 3, 2009
President Barack Obama

December 4, 2009

December 5, 2009

November 1, 2009

November 3, 2009

President Donald Trump

December 4, 2009

December 5, 2009

November 1, 2009

November 3, 2009

President Donald Trump
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.”

Other controversies regarding the use of the N95 respirator

Who Makes Decisions About Healthcare Worker Respiratory Protection In the United States?

TWO RESPIRATOR TYPES

- Air purifying - Removes contaminants before reaching breathing zone
- Atmosphere supplying - Provides fresh air from an external source

High Efficiency Particulate Air Filter (HEPA)

Filter that is at least 99.97% efficient in removing monodisperse particles of 0.3 micrometers in diameter.

Negative Pressure Respirator

A respirator in which the air pressure inside the face-piece is negative during inhalation with respect to the ambient air pressure outside the respirator.

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Filtering Face-piece (Dust Mask – N95)

A negative pressure particulate respirator with a filter as an integral part of the face-piece or with the entire face-piece composed of the filtering medium.

Powered Air-Purifying Respirator (PAPR)

An air-purifying respirator that uses a blower to force the ambient air through air-purifying elements to the inlet covering.

Respiratory Protection

- Airborne precautions
  - Particles < 5 µM
  - Remain suspended in air, can be dispersed by air currents
- Recommendation: fitted respirators meeting NIOSH N95 or better
- Source: CDC/APIC, 1999

More Protective Respirators

- Some hospitals recommend PAPR
- Advantages
  - more protective
    - NIOSH APF: Hooded: 25, Tight-fitting: 50
    - ANSI APF: 1000 for both
  - cooling
- Disadvantages
  - cost
  - weight
  - battery dependence
  - noise
- Need?

Respirator Program Elements

1. Selection
2. Medical evaluation
3. Fit testing
4. Use
5. Maintenance and care
6. Breathing air quality and use
7. Training
8. Program evaluation

Fit Testing

Before an employee uses any respirator with a negative or positive pressure tight-fitting face-piece, the employee must be fit tested with the same make, model, style, and size of respirator that will be used (using OSHA accepted protocol).
FIT TESTING

- Respirators rely on face-to-mask seal
- Fit testing determines which device will best fit and seal
- Stubble, beard, hairlines, glasses, and goggles will negatively affect fit
- Corrective lenses may be mounted inside the facepiece

Types of Fit Testing

- Qualitative (QLFT) – A challenge agent, vapor, or aerosol released
- Fit is inadequate if a presence of the agent is detected (irritation, taste, or odor)
- Quantitative (QNFT) - Measures actual level of agent both inside and outside the respirator

Fit Testing

- Employees using tight-fitting face-piece respirators must pass an appropriate qualitative fit test (QLFT) or quantitative fit test (QNFT):
  - before initial use,
  - whenever a different respirator face-piece (size, style, model or make) is used, and
  - at least annually thereafter
- Must conduct an additional fit test whenever there are changes in the employee’s physical condition (e.g., facial scarring, dental changes, cosmetic surgery, or obvious change in body weight) that could affect respirator fit

Types of Fit Testing (cont’d)

- The fit test must be administered using an OSHA-accepted QLFT or QNFT protocol.
  - QLFT Protocols:
    - Isoamyl acetate
    - Saccharin
    - Bitrex
    - Irritant smoke
  - QNFT Protocols:
    - Generated Aerosol (corn oil, salt, DEHP)
    - Condensation Nuclei Counter (PortaCount)
    - Controlled Negative Pressure (Dynatech FitTester 3000)

Qualitative Fit Test (QLFT)

A pass/fail fit test to assess the adequacy of respirator fit that relies on the individual’s response to the test agent.

Quantitative Fit Test (QNFT)

An assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator.
Is N95 Fit Testing Required?

- Most elements of the NIOSH respirator program (i.e., fit factor, protection estimates, etc.) are theoretical using mathematical models and have not been confirmed in practical work situations.

- In one NIOSH study, fit testing respirator assignment errors were as high as 20%.

From Bill Jarvis, CDC

Quantitative Fit Testing Does Not Ensure Health Care Worker Respiratory Protection

M Lee, S Takaya, R Long, M Joffe
SHEA Abstract - Apr 2005

- 58 HCW never fit-tested
- 25/58 (43%) passed initial fit-test
  - 19 passed with instruction = 76% total passes
- 3 months later, 49/58 re-tested
  - 47% recalled respirator type and passed fit-test
  - Passing at 3 months did not correlate with passing at initial fit-test or receipt of instruction

No, fit testing is not needed.

- No added value to adequate training:


Conclusion

- Fit testing of N95 respirators in the United States because of legal requirements not scientific data.
- Dust-mist and dust-mist fume (~N-95) respirators protected healthcare workers from M. tuberculosis, without fit testing.
- There are no data that healthcare workers are at greater risk of infection if they wear a respirator properly that has not been fit tested.
- Data show that healthcare workers were protected from SARS-CoV by N-95 respirators, without fit testing.
- No study has been done to document either the added protection or the cost-efficacy of fit testing in the respiratory protection of healthcare workers from infectious pathogens.
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Does good infection control practices work?
Clinical vs nonclinical HCWs: 6.0% vs 4.3% p<0.001
n = 526 HCWs in Saudi Arabia

“Infection control personnel were overstretched throughout the study”

CDC – 70 self infected HCWs and majority (80%) are clinical
“HCP may be at risk for occupational pH1N1”

Only 20% reported using mask during all encounters

This guidance replaces guidance documents issued on 29th April and 25th June 2009 and remains valid until 30th June 2010.

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>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number infected</th>
<th>Statistical significance (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. During mandatory reporting for all staff</td>
<td>119 (0.63%) vs 249 (0.62%) 0.82</td>
</tr>
<tr>
<td>B. Data during the entire pandemic period</td>
<td>NA vs 1039 (2.6%) 0.001</td>
</tr>
</tbody>
</table>

HK – 3.6% for same age group (Cowling et al. – accepted)

Exposed to pH1N1 in the community

<table>
<thead>
<tr>
<th>Contact history with confirmed case in community</th>
<th>Non-clinical</th>
<th>Clinical</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>16 (12.6%)</td>
<td>178 (17.1%)</td>
<td>0.74</td>
</tr>
<tr>
<td>Friend</td>
<td>8 (6.7%)</td>
<td>35 (3.4%)</td>
<td>0.11</td>
</tr>
<tr>
<td>Others - Public transportation</td>
<td>0</td>
<td>2 (0.2%)*</td>
<td></td>
</tr>
<tr>
<td>No perceived community contact</td>
<td>96 (80.7%)</td>
<td>824 (79.3%)</td>
<td>0.82</td>
</tr>
</tbody>
</table>

* 2 cases of ILIs – not confirmed case

Reporting of pH1N1 cases among HKHA staff

Mandatory reporting within HA for all staff – mid June to end of August – all staff
Testing is provided without charge at staff clinics
Testing done by RT – PCR and viral culture
Survey by ICN on all staff reported – demographic information clinical presentation nature of exposure

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<table>
<thead>
<tr>
<th>Exposures to pH1N1 in the hospital</th>
<th>Non-clinical (n=119)</th>
<th>Clinical (n = 1038)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unprotected exposure to confirmed case in healthcare facility</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colleague</td>
<td>10 (7.6%)</td>
<td>93 (8.4%)</td>
<td>0.97</td>
</tr>
<tr>
<td>Patient</td>
<td>0</td>
<td>9 (0.8%)</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>Protected exposure to patients</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>52 (5.1%)</td>
<td></td>
</tr>
<tr>
<td><strong>Infection perceived as due to patient care</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>26 (2.5%)</td>
<td>0.12</td>
</tr>
</tbody>
</table>

The greatest risk in the health care setting in Hong Kong is non-protected exposures to an unknown infected colleague – but it should be the same all over the city.

---

### Hand Hygiene compliance – Feb 2010

<table>
<thead>
<tr>
<th>Jobs Category</th>
<th>Total no</th>
<th>% compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nurse</td>
<td>13579</td>
<td>19056</td>
</tr>
<tr>
<td>Doctor</td>
<td>2322</td>
<td>4378</td>
</tr>
<tr>
<td>HCA &amp; supporting</td>
<td>6248</td>
<td>9127</td>
</tr>
<tr>
<td>Others</td>
<td>2328</td>
<td>3399</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>24477</td>
<td>35690</td>
</tr>
</tbody>
</table>

*Range: 30-96% by hospitals*

---

**The routine use of PPE when on duty**

<table>
<thead>
<tr>
<th>Routine PPE when on duty</th>
<th>Non-clinical</th>
<th>Clinical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical mask</td>
<td>70 (59%)</td>
<td>999 (96.2%)</td>
</tr>
<tr>
<td>N95</td>
<td>0</td>
<td>1 (0.1%)</td>
</tr>
<tr>
<td>Face shield</td>
<td>1 (0.8%)</td>
<td>30 (2.9%)</td>
</tr>
<tr>
<td>Eye shield</td>
<td>0</td>
<td>3 (0.3%)</td>
</tr>
<tr>
<td>Gloves</td>
<td>1 (0.8%)</td>
<td>1 (0.1%)</td>
</tr>
<tr>
<td>Gown</td>
<td>0</td>
<td>2 (0.2%)</td>
</tr>
</tbody>
</table>

---

85% not vaccinated
Feb – March 2010

<table>
<thead>
<tr>
<th></th>
<th>Non-clinical</th>
<th>Clinical</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cases (n)</td>
<td>147</td>
<td>439</td>
<td></td>
</tr>
<tr>
<td><strong>Positive serology titre ≥ 1:40</strong></td>
<td>20 (14%)</td>
<td>54 (12%)</td>
<td>0.79</td>
</tr>
</tbody>
</table>

*There was no statistically significant difference between HCWs and community population in March 2010 in the proportion with antibody titre ≥1:40*

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“Infection control guidelines for the pandemic were issued very early on 29 April 2009 stipulating droplet precautions as recommended by the World Health Organization.

Educational sessions conducted organization-wide have more than 39,000 staff in attendance.”

Seto et al, CID

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COMING SOON …

- 31 August 11 (Free WHO Teleclass) Latest Update on Clostridium difficile Control
  Speaker: Dr. Andreas Widmer, University Hospital of Basel, Switzerland
  Sponsor: World Health Organization First Global Patient Safety Challenge: Clean Care is Safer Care (www.who.int/gpsc/en)

- 07 September 11 (Free WHO Teleclass) Highlights and Results from May 5, 2011 Initiatives Around the World
  Speaker: Claire Kilpatrick and Benedetta Allegranzi, WHO Patient Safety Challenge
  Sponsor: World Health Organization First Global Patient Safety Challenge: Clean Care is Safer Care (www.who.int/gpsc/en)

- 08 September 11 Practical Aspects of Hospital Infection Control for Influenza
  Speaker: Dr. Fidelma Fitzpatrick, HPSC and Beaumont Hospital, Ireland

- 19 September 11 (Free British Teleclass, Broadcast Live from the Infection Prevention Society Conference – www.ips.uk.net)
  Speaker: Anne Bialachowski, Past President, CHICA-Canada
  Sponsored by: GOJO Industries – Europe Ltd (www.gojo.com)

www.webbertraining.com/schedulep1.php

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