SWINE-ORIGIN H1N1 INFLUENZA AND INFECTION CONTROL CONSIDERATIONS FOR HEALTHCARE FACILITIES

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• Although PPE for HCWs is important, the impact of source control (ie, masking patients with ILI), engineering and administrative controls should not be underestimated nor should we underestimate the risk posed from infected HCWs in addition to infected patients.

• Cough etiquette/hand hygiene stations at major entrances to hospital, in ED & clinics (ie, masks for patients & family members with ILI, alcohol hand hygiene product dispenser, and instructions for masking and hand hygiene)
Table 1. Efficacy of surgical and N95 masks to filter influenza in point-of-care assay–positive patients.

<table>
<thead>
<tr>
<th>Patient or variable</th>
<th>Influenza type</th>
<th>Nasal swab</th>
<th>No mask, before control (step 1)</th>
<th>N95 mask (step 2)</th>
<th>Surgical mask (step 3)</th>
<th>No mask, after control (step 4)</th>
<th>Duration of illness, days per week</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>28</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative</td>
<td>39</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>26</td>
<td>40</td>
<td>Negative</td>
<td>Negative</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>A</td>
<td>22</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative</td>
<td>35</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>A</td>
<td>26</td>
<td>34</td>
<td>Negative</td>
<td>Negative</td>
<td>35</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>A</td>
<td>23</td>
<td>32</td>
<td>Negative</td>
<td>Negative</td>
<td>33</td>
<td>2</td>
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<tr>
<td>6</td>
<td>A</td>
<td>25</td>
<td>27</td>
<td>Negative</td>
<td>Negative</td>
<td>25</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>B</td>
<td>22</td>
<td>33</td>
<td>Negative</td>
<td>Negative</td>
<td>27</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>A</td>
<td>23</td>
<td>34</td>
<td>Negative</td>
<td>Negative</td>
<td>39</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>B</td>
<td>27</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative</td>
<td>39</td>
<td>3</td>
</tr>
<tr>
<td>Mean cycle time for patients with detected influenza A</td>
<td>...</td>
<td>28&lt;sup&gt;a&lt;/sup&gt;</td>
<td>34.17&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0</td>
<td>0</td>
<td>34.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Estimate viral load for detectec influenza A, copies/mL</td>
<td>...</td>
<td>5 million&lt;sup&gt;a&lt;/sup&gt;</td>
<td>50,000&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0</td>
<td>0</td>
<td>50,000&lt;sup&gt;a&lt;/sup&gt;</td>
<td>...</td>
</tr>
</tbody>
</table>

**NOTE.** Cycle number indicates real-time reverse transcription-polymerase chain reaction cycle number. The cycle number value is inversely proportional to the titer of virus present.

<sup>a</sup> Mean value calculated from patients with detectable influenza A.

<sup>b</sup> Mean duration.
H1N1 (Swine) Flu Precautions

For Patients:
If you are experiencing flu-like symptoms, including:
- Fever and cough, and/or sore throat
please put on a mask to prevent the spread of illness.
Use the Purell hand sanitizer dispensers to kill germs on your hands.

For Visitors:
Visitors with flu-like symptoms are asked not to visit hospital patients unless it is absolutely essential. Such visitors will be asked to wear a mask.
Use the Purell hand sanitizer dispensers to kill germs on your hands.

Thank you

Lifespan
Helping Our Hospitals Take the Best Care of You
Rhode Island Hospital/Hasbro Children’s Hospital,
The Miriam Hospital, Bradley Hospital, Newport Hospital

Precauciones que debe tomar para protegerse en contra de la influenza porcina

Para los pacientes:
Si usted está experimentando síntomas parecidos a los de la influenza, incluyendo:
- Fiebre y tos, y/o dolor de garganta,
póngase una máscara para prevenir la propagación de la enfermedad.
Utilice los dispensadores de desinfectantes de manos Purell para matar a los gérmenes en sus manos.

Para los visitantes:
Se les pide a los visitantes que tienen síntomas parecidos a los de la influenza que no visiten a los pacientes del hospital, a menos que sea absolutamente esencial. A esos visitantes se les pedirá que usen una máscara.
Utilice los dispensadores de desinfectantes de manos Purell para matar a los gérmenes en sus manos.

Muchas gracias

Precauções a ter com a gripe suína para sua proteção

Para os pacientes:
Se você sentir sintomas semelhantes aos da gripe, incluindo:
- Fiebre e tosse, e/ou dor de garganta
por favor, ponha uma máscara para prevenir o espalhar da doença.
Use os dispensadores de desinfetantes para a higiene das mãos Purell para matar os gérmenes nas suas mãos.

Para os visitantes:
Visitantes com sintomas semelhantes aos da gripe estão pedidos para não visitar os pacientes a não ser que seja absolutamente indispensável. A tais visitantes ser-lhes-á pedido para usar uma máscara.
Use os dispensadores de desinfetantes para a higiene das mãos Purell para matar os gérmenes nas suas mãos.

Muito obrigado
Infection Control Precautions in Healthcare settings

- Educational material for patients/visitors and employees/staff re: infection control and influenza (eg, how to properly put on and remove PPE)
- Patients with ILI who cannot wear a mask should have priority for going directly into an exam room
- Cohort patients with ILI in waiting rooms; chairs 3 ft apart in waiting rooms
- Limit visitation
- Standard + Droplet Precautions in single patient rooms
DROPLET PRECAUTIONS

Visitors - Report to Nurses’ Station
Before Entering Room

STOP

MASK REQUIRED within 6 feet of patient

N95 RESPIRATOR for aerosol generating procedures *

EYE PROTECTION within 6 feet of patient

IN ADDITION TO STANDARD PRECAUTIONS:

PRIVATE ROOM: required. Door may remain open.
CLEAN HANDS: with an alcohol hand gel or an antimicrobial soap before leaving the room.
EQUIPMENT: Clean and disinfect ALL EQUIPMENT before it leaves room.
AEROSOL GENERATING PROCEDURES*: performed in a Negative Pressure room, if available, otherwise keep door shut.
VISITORS: are required to wear a surgical mask.
TRANSPORT: Patient wears a surgical mask. Drape patient in a clean sheet, clean stretcher or wheelchair.

- aerosolized or nebulized medication administration, high-flow oxygen mask use, positive pressure ventilation via face mask (BiPAP or CPAP), high-frequency oscillatory ventilation and cough-inducing procedures such as sputum induction, bronchoscopy, nasopharyngeal aspiration, endotracheal intubation, and during airway suctioning with an open system

DO NOT REMOVE SIGN UNTIL THE ROOM HAS BEEN CLEANED
A healthy person’s cough expels turbulent jet of air; density changes distort a projected schlieren light beam (Panel A). Velocity map early in the cough (Panel B) is shown. Sequential schlieren images during the cough (Panel C). Maximum airspeed of 18 mph observed. Cough plume may project infectious aerosols into surrounding air.

Tang & Settles NEJM 2008
Oxygen mask on a simulator representing 70 kg male with mild lung injury sitting on a hospital bed inclined to 45° and spontaneously breathing 14 breaths/min
Subject exhaling previously inhaled saline aerosol mist while wearing nonrebreathing oxygen mask (top, A) and Venturi-type oxygen mask (bottom, B). Plume represents only exhaled breath because there was no oxygen flow into the masks.

Somogyi et al.  
Chest 2004;125:1155-1157
Exhaled aerosol dispersal pattern during high-flow oxygen administration with a conventional face mask.
Fowler et al, NEJM 351;610, 2004
Total exhaled bioaerosol following expiration over 6 hours: monitoring inhaled air after inhalation of isotonic saline; exhaled bioaerosols suppressed (72%) for 6 hours following isotonic saline treatment

Edwards et al. PNAS 2004
• fit-tested N-95 respirator (or PAPR) for high-risk procedures; neg pressure room if possible
  – Intubation/extubation, CPR, or manual ventilation (stock crash carts accordingly)
  – High-flow oxygen mask use (any $O_2$ mask?)
  – Positive pressure ventilation via face mask (BiPAP or CPAP)
  – High frequency percussive ventilation
  – High frequency oscillatory ventilation
  – Jet nebulizer (esp. if saline not used as diluent)
  – Airway suctioning with an open system
  – Nasopharyngeal aspiration
  – Sputum induction
  – Bronchoscopy
  – Autopsy
• Limit as much as possible non-essential potential high-risk procedures
• Swine flu-immune HCWs (ie, recovered from swine flu or fully vaccinated) should preferentially perform potential high-risk procedures and care for superspreaders, if known
• Filters (e.g., micropore or small-volume heat and moisture exchange filter) on expiratory limb of ventilators, especially high-frequency ventilators, and on ambu-bags
• If possible, perform intubation on patients who are sedated (e.g. midazolam) and paralyzed (e.g. succinylcholine) to minimize coughing and facilitate intubation
• Clear guidance re: any employee or HCW with ILI must not report to work or stop working if at work and contact employee health
• Clear guidance on when to return to work after ILI (including w/ and w/o antiviral treatment)
• Consider daily screening HCWs & other hosp employees for fever and respiratory symptoms before starting their shift (28% of US HCWs with S-O H1N1 appear to have acquired infection from ill HCWs, Dr. L. Hicks, personnel communication 8/4/09)
• Routine daily and discharge cleaning
• If possible, increase indoor relative humidity to 50% and maintain indoor temperature to >68ºF
• Appropriate hospital ventilation
Unresolved Issues Regarding Influenza Transmission and My Musing...

• Do healthcare settings create unique circumstances for influenza transmission? (yes, due to patient care procedures not routinely done in community settings)
• Can opportunistic airborne spread occur in healthcare settings, and if so, which procedures are most apt to lead to such transmission? (yes, eg, NPPV)
Exhaled breath particle size distribution averaged from 10 symptomatic, influenza-infected subjects

• Aerosols of influenza virus are generated during tidal breathing in symptomatic, influenza-infected individuals
• Over 87% of subjects exhaled particles under 1 micron in size
• 50% of subjects exhaled >500 particles/liter, a suggested threshold for high particle producers
• ‘Influenza virus may be contained in fine particles generated during tidal breathing, and add to the body of literature suggesting that fine particle aerosols may play a role in influenza transmission’

• What is the impact of short-range small particle aerosols vs droplet spread in influenza transmission risk to HCWs during routine patient care?

If small particle aerosols play a significant role in the absence of aerosol-generating procedures, then one would expect that a high incidence of influenza among HCWs historically with use of droplet precautions.

• Should an N95 respirator be worn by HCW if the patient with ILI can’t or won’t wear a mask (ie, we can’t obtain source control)?
Individuals who are Superspreaders of Infectious Agents: Implications for Control of Transmission During a Pandemic

Lloyd-Smith et al, Nature 2005
• SARS cases in Singapore: 73% of infected individuals spread SARS to <1 susceptible people; however, 6% of SARS-infected individuals spread SARS to >8 other susceptible people
a, Transmission data from SARS outbreak, Singapore 2003. Bars show observed frequency of Z, # individuals infected by each case. Lines show max-likelihood fits for Z Poisson (squares), Z geometric (triangles), and Z negative binomial (circles). Inset, probability density function (solid) and cumulative distribution function (dashed) for gamma-distributed (corresponding to Z negative binomial) estimated from Singapore SARS data. 

b, Expected proportion of all transmission due to given proportion of infectious cases, where cases are ranked by infectiousness. For homogeneous population (all = R₀), relation is linear. For 5 directly transmitted infections, the line is concave owing to variation in R₀. Proportion of transmission expected from the most infectious 20% of cases, for 10 outbreak or surveillance data sets (triangles). Dashed lines show proportions expected under the 20/80 rule (top) and homogeneity (bottom).

Superscript 'v' indicates partially vaccinated pop. 

d, Reported superspreading events (SSEs; diamonds) relative to estimated reproductive number R (squares) for 12 directly transmitted infections. Lines show 5–95% range of Z Poisson(R), and crosses show 99% proposed as threshold for SSEs. Stars represent SSEs caused by more than one source case. 'Other' diseases are: 1, group A Strep; 2, Lassa fever; 3, Mycoplasma pneumonia; 4, pneumonic plague; 5, tuberculosis. R not shown for 'other' diseases, is off-scale for monkeypox.

Lloyd-Smith et al, Nature 2005
Total exhaled bioaerosol from 11 volunteers over a 6 hours. 6 individuals produced 99% of total number of exhaled bioaerosols.

Edwards et al. PNAS 2004; Fiegel J. Drug Discovery Today. 2006
• How can we predict superspreaders? (baseline high-particle generating influenza-infected individual [reason unknown], re: influenza, since viral shedding appears to have a correlation with severity of illness, superspreaders may be those who are most immunocompromised and without cross-reacting Ab [eg, a 16 y/o transplant recipient])

• If we could predict superspreaders at triage desk, should they be placed in airborne precautions (ie, ≥ N-95 respirators for routine care (yes))
Experimental Set-Up

Balazy, et al. AJIC. 2006;34:51-7
Effect of inhalation flow rate on the fractional penetration of MS2 virus through respirator A (n = 5). Each point represents mean value of particle penetration.

Balazy, et al. AJIC. 2006;34:51-7
Effect of inhalation flow rate on the fractional penetration of MS2 virus through respirator B (n = 5). Each point represents mean value of particle penetration.

Balazy, et al. AJIC. 2006;34:51-7
Effect of inhalation flow rate on fractional penetration of MS2 virus through the surgical mask SM1 (n =2). Each point represents the mean penetration value.
Effect of inhalation flow rate on fractional penetration of MS2 virus through the surgical mask SM2 (n = 3). Each point represents the mean penetration value.

Balazy, et al. AJIC. 2006;34:51-7
Aerosol penetration through filter media of eight surgical masks

Why doesn’t the federal government have an easy to access web site containing a comparative chart of the viral filtration capacity of all US marketed procedure & surgical masks and N95 respirators tested for viral penetration with a listing of the brand, model number, manufacturer? This would not be an endorsement, but simply state the facts.
• Does jet nebulization use with saline completely mitigate risk of opportunistic aerosol transmission? (unlikely but unknown)

• Is eye protection important to reduce risk of acquiring influenza (conjunctiva has $\alpha$ 2,3-galactose-linked sialic acid receptors, but could virions pass down lacrimal duct to respiratory tract?) (influenza found in the conjunctiva on d 3 of infection in one recent animal study)

• How long should masks and respirators be worn before they should be changed?
Sign in Chicago during 1918 pandemic

INFLUENZA
FREQUENTLY COMPLICATED WITH
PNEUMONIA
IS PREVALENT AT THIS TIME THROUGHOUT AMERICA.
THIS THEATRE IS CO-OPERATING WITH THE DEPARTMENT OF HEALTH.
YOU MUST DO THE SAME
IF YOU HAVE A COLD AND ARE COUGHING AND
SNEEZING, DO NOT ENTER THIS THEATRE
GO HOME AND GO TO BED UNTIL YOU ARE WELL

Coughing, Sneezing or Spitting Will Not Be Permitted In The Theatre. In case you must cough or Sneeze, do so in your own handkerchief, and if the Coughing or Sneezing Persists Leave The Theatre At Once.

This Theatre has agreed to co-operate with the Department Of Health in disseminating the truth about Influenza, and thus serve a great educational purpose.

HELP US TO KEEP CHICAGO THE HEALTHIEST CITY IN THE WORLD

JOHN DILL ROBERTSON
COMMISSIONER OF HEALTH