Swine Influenza Surveillance: Hong Kong / China & Sri Lanka

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Abattoir surveillance in Hong Kong/China

Hong Kong
- 4000–5000 pigs are slaughtered each day.
- Only 5-20% of pigs are from Hong Kong.

May 2009 to date:
- 504 swabs collected monthly, 100 sera
Abattoir surveillance in Hong Kong: Isolation rates increased over recent years

<table>
<thead>
<tr>
<th>Year</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolates</td>
<td>21</td>
<td>19</td>
<td>47</td>
<td>25</td>
<td>78</td>
<td>124</td>
<td>314</td>
</tr>
<tr>
<td>Samples</td>
<td>3024</td>
<td>3024</td>
<td>5027</td>
<td>3960</td>
<td>5067</td>
<td>4908</td>
<td>25010</td>
</tr>
<tr>
<td>%</td>
<td>0.69%</td>
<td>0.63%</td>
<td>0.93%</td>
<td>0.63%</td>
<td>1.54%</td>
<td>2.53%</td>
<td>1.26%</td>
</tr>
</tbody>
</table>
Influenza sero-prevalence in swine sera collected April 2011-12 (n=260)

- HI tests
- MN tests
- bELISA

% seropositive

- H3N2
- Any H1
- H9N2 Bei
- H9N2 G1 (Yu250/12)
- H9N2 G1 (33982/11)
- bELISA
- bELISA Extra pos
## Swine Influenza Genotypes after 2009

<table>
<thead>
<tr>
<th>Year</th>
<th>H3N2</th>
<th>G3</th>
<th>G5</th>
<th>M1</th>
<th>M2</th>
<th>NS</th>
<th>HA</th>
<th>NA</th>
<th>M3</th>
<th>M5</th>
<th>M7</th>
<th>M8</th>
<th>M11</th>
<th>H1</th>
<th>H2</th>
<th>H3</th>
<th>H4</th>
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<tbody>
<tr>
<td>1975-76</td>
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<td>1985-86</td>
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<td>1995-96</td>
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<td>2005-06</td>
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<td>2015-16</td>
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</tbody>
</table>

**Legend:**
- **H3N2**: Human-like
- **G3**: M1 receptor
- **G5**: M2 receptor
- **M1**: NS receptor
- **M2**: HA receptor
- **M3**: NA receptor
- **M5**: MNP receptor
- **M7**: M21 receptor
- **M8**: M22 receptor
- **M11**: Human-like
- **H1**: M1 receptor
- **H2**: M2 receptor
- **H3**: HA receptor
- **H4**: NA receptor

**Legend for Transient Variants:**
- **Acip**: AcipHex
- **Hu-H1**: Human-H1
- **Hu-H2**: Human-H2
- **Hu-H3**: Human-H3
- **Hu-H4**: Human-H4
- **Tr**: Transient
- **Pna-G5**: Pna-G5

**Notations:**
- **X**: Presence of genotype

**Dates:**
- 1999
- 2009

**Highlighted Period:**
- 1999 - 2009

**Highlighted Genotypes:**
- G3 and M2 receptors
- M1 and M2 receptors

**Important Note:**
- The highlighted period and genotypes indicate a period of significant genetic diversity and adaptation among swine influenza viruses.
Increase of swine influenza viruses with pandemic H1N1 genes

<table>
<thead>
<tr>
<th></th>
<th>2009 (n=47)</th>
<th>2010 (n=25)</th>
<th>2011 (n=78)</th>
<th>2012 (n=124)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA or TGIG swine No Pdm genes</td>
<td>80.9</td>
<td>68.0</td>
<td>23.1</td>
<td>25.0</td>
</tr>
<tr>
<td>Pure Pdm viruses</td>
<td>19.1</td>
<td>28.0</td>
<td>6.4</td>
<td>0.0</td>
</tr>
<tr>
<td>Pdm Reassortants</td>
<td>0.0</td>
<td>4.0</td>
<td>70.5</td>
<td>75.0</td>
</tr>
</tbody>
</table>
Risk-assessing swine viruses

Tropism for human upper respiratory tract
Ex vivo cultures

Transmission in ferrets

Human infection
Serological herd immunity

Nicholls et al., 2007 Nat Med;
Establishment of an H3N2r virus

HA, NA: human H3N2/04 lineage

Internal genes: pH1N1/09

H3 HA
H3N2v infection in \textit{ex vivo} human respiratory cultures

A/SW/GX/NS2783/2010  A/SW/HK/NS2811/11  A/ST/546/10

Bronchus: A, B, C

Lung: D, E, F

Graphs: G, H, I
Pandemic reassortant H3N2 virus

Airborne transmission in ferrets

<table>
<thead>
<tr>
<th></th>
<th>CA7-pH1N1/09</th>
<th>NS2811-H3N2r</th>
</tr>
</thead>
<tbody>
<tr>
<td>detection of virus shedding (dpc)</td>
<td>4,7,11,25</td>
<td>(-)</td>
</tr>
<tr>
<td>virus shedding/detected period (days)</td>
<td>4,6,8,5</td>
<td>(-)</td>
</tr>
<tr>
<td>seroconversion (15 dpc)</td>
<td>2/4</td>
<td>1/4</td>
</tr>
<tr>
<td>seroconversion (35 dpc)</td>
<td>4/4</td>
<td>1/4</td>
</tr>
</tbody>
</table>

Population sero-prevalence (Hong Kong)

* A/sw/Guangxi/NS2783/10 (H3N2) * 

HI titres ≥40
Risk assessing swine influenza viruses
Age-stratified cross-reactive antibody in human population

A/Sw/HK/4085/2011

% Seropositive

<table>
<thead>
<tr>
<th>Age (yrs)</th>
<th>1-20 yr</th>
<th>21-40 yr</th>
<th>41-60 yr</th>
<th>61-80 yr</th>
<th>&gt;80 yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Seropositive</td>
<td>70</td>
<td>30</td>
<td>20</td>
<td>40</td>
<td>50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Virus</th>
<th>Isolation date</th>
<th>Subtype</th>
<th>PB2</th>
<th>PB1</th>
<th>PA</th>
<th>HA</th>
<th>NP</th>
<th>NA</th>
<th>M</th>
<th>NS</th>
</tr>
</thead>
</table>
Risk assessing swine influenza viruses
Age-stratified cross-reactive antibody in human population

A/sw/HK/NS584/12

% Seropositive

Age (yrs)

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<tr>
<th>Virus</th>
<th>Isolation date</th>
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<th>PB1</th>
<th>PA</th>
<th>HA</th>
<th>NP</th>
<th>NA</th>
<th>M</th>
<th>NS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A/Swine/HongKong/NS584/2012</td>
<td>16/Feb/12</td>
<td>H1N2</td>
<td>pH1N1</td>
<td>pH1N1</td>
<td>pH1N1</td>
<td>EA</td>
<td>TR</td>
<td>TR-N2</td>
<td>EA</td>
<td>pH1N1</td>
</tr>
</tbody>
</table>

Diagram shows the percentage of seropositive individuals across different age groups for the specified virus and subtype.
Risk assessing swine influenza viruses
Age-stratified cross-reactive antibody in human population

A/Sw/HK/2378/2012

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<thead>
<tr>
<th>Virus</th>
<th>Isolation date</th>
<th>Subtype</th>
<th>PB2</th>
<th>PB1</th>
<th>PA</th>
<th>HA</th>
<th>NP</th>
<th>NA</th>
<th>M</th>
<th>NS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A/Swine/HongKong/NS2378/12</td>
<td>5-Jul-12</td>
<td>H1N1</td>
<td>EA</td>
<td>EA</td>
<td>EA</td>
<td>EA</td>
<td>EA</td>
<td>EA</td>
<td>pH1N1</td>
<td>EA</td>
</tr>
</tbody>
</table>
Sero-conversion to pandemic H1N1 is associated with broadened MN cross-reactivity to other swine H1N1 viruses, but not to avian H1N1 viruses.

Perera et al EID 2011
Swine surveillance in Sri-Lanka (2009-2012)

Demography
Swine Population - ~100000; Density - (7.7 per square Km)
Not imported on regular basis
Study: 2009 August - 2012 May
   Nasal and Tracheal swab - 5420
   Serum samples - 1773

• Results: Viral isolation
• 26 H1N1pdm-like (26/5420, 0.5%) viruses isolated
• 12 sampling occasions; 7 different swine farms
• No other swine influenza viruses were detected by virus isolation or serology
• Previously a “human-like” H3N2 was in widespread circulation in swine in period 2004 till 2009

Perera et al Emerg Infect Dis 2013; 19 (3); 481-484

Perera et al Emerg Infect Dis 2013; 19 (3); 481-484