Impact of influenza vaccination on influenza antibody response and unplanned hospital admissions among community-dwelling Chinese elderly in Hong Kong

A randomised controlled trial

Dr. L. W. Chu

Consultant, Department of Medicine, Queen Mary Hospital
Consultant i/c, Hong Kong West Cluster Geriatrics Service
Honorary Clinical Associate Professor, Department of Medicine, Faculty of Medicine, the University of Hong Kong
Burden of Influenza infection in the elderly

- Influenza infection is associated with
  - Increased mortality, morbidity and hospitalizations (overseas* & HK** data)

- Globally, the influenza virus
  - infects about 10-20% of our population annually

- Influenza & its associated complications accounts for
  - More than 3 million cases of severe illness and
  - up to 0.5 million deaths every year

*Cox, 2000; WHO, 2002; Stephenson. 2002; Couch, 2000

Prevention of influenza illness and associated complications in the elderly

Prevention by annual influenza vaccination is recommended by many countries (incl. US, Europe)

Efficacy in

- both the nursing home elderly & community elderly *
  - nursing home elderly > community elderly

However, there is no data in the Chinese elderly in Hong Kong on the

- immune response and clinical impact of influenza vaccination on hospitalizations

Review* of 64 Caucasians studies
Aims of the Study

To investigate the immune antibody response to influenza vaccine in the community-dwelling Chinese elderly in Hong Kong

To explore the possible beneficial effect of influenza vaccination in decreasing unplanned hospital admissions in the elderly
Methods and Subjects

- **Design**: a randomized, single-blind, and placebo-controlled trial.
  - Subjects (were blinded to the group assignment); the nurse (not blinded)

- **Subjects** were community-dwelling elderly (Geriatric Clinic and SYP GOPC)
  - **Inclusion criteria** were:
    - Chinese ethnicity,
    - age ≥ 60 years old,
    - could understand and willing to comply with the study and 6-month follow-up,
    - living in the community and
    - written informed consent.
  - **Exclusion criteria** were:
    - infectious diseases,
    - fever (temperature ≥ 37.5 °C) at baseline visit,
    - living in institutions (old age homes),
    - known allergy to egg or influenza vaccines,
    - cancer and other serious diseases.
Subjects were randomized to receive either influenza vaccine or placebo injections

**Vaccine Group:**
- trivalent subunit inactivated influenza vaccine, VaxiGrip*, imi
  - which contained 15 μg of each of the 3 viral strains
    - A/New Caledonia/20/99 (H1N1)
    - A/Moscow/10/99 (H3N2)
    - B/Hong Kong/330/2001
  - was based on the WHO recommendation for the Northern hemisphere for 2003/2004 (Winter)

**Placebo Group:**
- Equal volume Normal Saline

*Sanofi Pasteur, France*
6-month follow-up (FU)
Outcome measures

- Immune antibody response to influenza vaccine HI antibody: 3 parameters
  (technician was blinded to group assignment of subjects)
  - GMT (of HI antibody)
  - PR (with HI $\geq$ 1:40; regarded as seroprotective)
  - Seroconversion (4-fold increase in HI antibody titre)

- Unplanned hospital admissions

---

GMT HI = Geometric mean titre of haemagglutination inhibition antibody
PR = seroprotection rate
Results

- 128 subjects were recruited
- Mean age 74.4 years; 52.3% males
  - 65 vaccine group
  - 63 placebo control group
Results

- No significant baseline difference between the two groups
  - age, nutritional status, functional status, cognitive status, living arrangement, previous history of influenza vaccination and medical condition.

- No significant baseline difference between the two groups in their HI antibody titres
  - the seroprotection rates (PR; HI $\geq$ 1:40)) and Geometric Mean Titers (GMT) of the

- Exception: gender:
  - the vaccine group had a significantly lower frequency of males than the control group

HI= Haemagglutination Inhibition
Results

6-month FU 96.1%

HI Antibody response

Influenza vaccination provoked a protective HI antibody response
  – Most sensitive parameter is the GMT
Influenza vaccination provoked a protective HI antibody response in the elderly

<table>
<thead>
<tr>
<th>Influenza strain</th>
<th>HI Antibody response outcome measures</th>
<th>Vaccine versus Controls</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-H1N1:</td>
<td>PR</td>
<td>Increase &gt; controls</td>
<td>&lt;0.05 at 4wk, 6m</td>
</tr>
<tr>
<td></td>
<td>GMT</td>
<td>Increase &gt; controls</td>
<td>&lt;0.05 at 4wk, 6m</td>
</tr>
<tr>
<td></td>
<td>Seroconversion</td>
<td>Increase &gt; controls</td>
<td>&lt;0.05 at 4wk, 6m</td>
</tr>
<tr>
<td>A-H3N2:</td>
<td>PR*</td>
<td>No sign. increase</td>
<td>NS at 4wk</td>
</tr>
<tr>
<td></td>
<td>GMT</td>
<td>Increase &gt; controls</td>
<td>&lt;0.05 at 4wk, 6m</td>
</tr>
<tr>
<td></td>
<td>Seroconversion</td>
<td>Increase &gt; controls</td>
<td>&lt;0.05 at 4wk, 6m</td>
</tr>
<tr>
<td>B-HK:</td>
<td>PR*</td>
<td>No sign. increase</td>
<td>NS at 4wk, 6m</td>
</tr>
<tr>
<td></td>
<td>GMT</td>
<td>Increase &gt; controls</td>
<td>&lt;0.05 at 4wk, 6m</td>
</tr>
<tr>
<td></td>
<td>Seroconversion</td>
<td>Increase &gt; controls</td>
<td>&lt;0.05 at 4wk, 6m</td>
</tr>
</tbody>
</table>

*High baseline PR with no room for increase
### Geometric mean titers (GMT) of HI antibody in vaccinated and placebo groups

<table>
<thead>
<tr>
<th>Antigen Group</th>
<th>Before vaccination</th>
<th>4 weeks</th>
<th>6 month</th>
</tr>
</thead>
<tbody>
<tr>
<td>AH1N1 Vaccine</td>
<td>26.3</td>
<td>144.9</td>
<td>78.2</td>
</tr>
<tr>
<td>Control</td>
<td>27.5</td>
<td>30.1</td>
<td>30.1</td>
</tr>
<tr>
<td>*p value</td>
<td>0.633</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>AH3N2 Vaccine</td>
<td>80.9</td>
<td>632.8</td>
<td>435</td>
</tr>
<tr>
<td>Control</td>
<td>84.5</td>
<td>93.3</td>
<td>93.3</td>
</tr>
<tr>
<td>*p value</td>
<td>0.830</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>BHK Vaccine</td>
<td>120.5</td>
<td>584.4</td>
<td>371</td>
</tr>
<tr>
<td>Control</td>
<td>125.9</td>
<td>128.8</td>
<td>121.3</td>
</tr>
<tr>
<td>*p value</td>
<td>0.489</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*Between group comparison by Mann-Whitney U test

- The HI antibody level is at a high level for at least 6 months
- In multivariate analysis, only the vaccination status was the independent predictor of GMT
- Gender and age were not significant predictors
% of subjects with unplanned hospital admissions

% of subjects who had been hospitalized at least once

- Relative Risk (RR), vaccine vs. placebo group = 0.302
- Relative Risk Reduction 69.8% (or 78% after gender & age adjustment)
- NNT = 9 to prevent one unplanned hospitalization
  (95% C.I. = 5 to 143)

1. \( p=0.04 \); Chi-square statistics
2. Logistic regression adjusted for age and gender; \( p=0.031 \), \( RR =0.22 \),
  (95% CI 0.05-0.87)

NNT=Number Needed to Treat
[=1/Absolute risk reduction, which is 11.1% (15.9%-4.8%);
Cost of vaccine approx. HK$37]
Decreased hospitalizations explained by the HI antibody response of A-H3N2

*Multivariate Logistic Regression Model

Predictors of unplanned hospitalization*

- The 4-week A-H3N2 PR (HI ≥ 40)
  - Led to 92% less risk of hospitalizations
  - $RR_{Hospitalization} = 0.078$ (95% CI = 0.01, 0.023)

- Serum albumin level (g/dL)
  - $RR=0.6$ (95% CI = 0.43, 0.82)

- Chronic obstructive airway disease
  - $RR=150$ (95% CI = 10.1, 2237.2)

Notes: 93% viral isolates were A-H3N2 (during 2004)

4 weeks is the expected time for peak antibody response
Discussion and Conclusions

1\textsuperscript{st} RCT on influenza vaccination in the HK elderly

We found good influenza HI antibody response to influenza vaccine

– The antibody level was well maintained to be protective at 6 months

cover both the winter & summer “flu” peak seasons in this sub-tropical climate in HK
Conclusions & Recommendation

- Influenza vaccine reduces approx. 70% of hospitalizations
  - Vaccinating 9 elderly persons would prevent 1 hospitalization
- Free annual influenza vaccination to all community elderly in HK is recommended
  - Reduce influenza-associated hospitalizations* by 70%
    - Save 1317 unplanned admissions (=HK$13.17 m.**) (can relieve the winter time bed crisis).
  - Model: Public-private collaboration
    - DH - free vaccine & private family doctor- administer vaccine

*Excess no. of influenza increases flu-associated hospitalizations for 65+ pop. in HK =1882 (calculated from data reported by Wong CM, Peiris JSM, et al. sPLOS Medicine March 2006))

**Cost of vaccine HK$37 to HK$50 vs. Cost of 3 days of acute hospital stay (~HK$ 10,000)
Acknowledgement

Research Team Members

- Ms. SL Hui, RN
  - Department of Medicine, QMH

- Prof. JS Malik Peiris (Professor) &
- Dr. KH Chan
  - Department of Microbiology, QMH, HKU

- Dr. Daniel Chu (Consultant) &
- Dr. Wendy Tsui (Assoc. Consultant)
  - Department of Family Medicine, Sai Ying Pun General Out-Patient Clinic

- Funding support: Vice-Chancellor’s Development Fund

- The Editors and Reviewers of the journal “Vaccine”*

Thank You
## Baseline Characteristics of Subjects

\(n=128\)

<table>
<thead>
<tr>
<th></th>
<th>Vaccinated group n=65</th>
<th>Placebo group n=63</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender –Male, n (%)</td>
<td>27 (41.5)</td>
<td>40 (63.5)</td>
<td>0.010</td>
</tr>
<tr>
<td>Age(years), mean±SD</td>
<td>74.75±7.6</td>
<td>74.03±7.3</td>
<td>0.583</td>
</tr>
<tr>
<td>BW(kg), mean±SD</td>
<td>58.8±10.6</td>
<td>61.3±12.8</td>
<td>0.218</td>
</tr>
<tr>
<td>BMI, mean±SD</td>
<td>21.8±3.2</td>
<td>21.9±3.4</td>
<td>0.880</td>
</tr>
<tr>
<td>Hgb (g/l) , mean±SD</td>
<td>13.2±1.3</td>
<td>13.5±1.4</td>
<td>0.170</td>
</tr>
<tr>
<td>Albumin, mean±SD</td>
<td>42.1±2.4</td>
<td>41.7±3.0</td>
<td>0.454</td>
</tr>
<tr>
<td>Number of co-morbid diseases, mean±SD</td>
<td>1.48±0.9</td>
<td>1.62±0.9</td>
<td>0.361</td>
</tr>
<tr>
<td>Barthel Index , mean±SD</td>
<td>19.8±0.6</td>
<td>19.6±1.0</td>
<td>0.19</td>
</tr>
</tbody>
</table>
6-month FU 96.1%

Primary Outcome

Antibody Response
Unplanned hospitalizations
6 months of follow-up

Unplanned hospital admissions

The mean number of unplanned hospital admissions was
- 68.8% lower in the vaccinated vs. placebo groups
- 0.05±0.21 versus 0.16±0.37 respectively

p<0.05, independent t-test
Geometric mean titers (GMT) of HI in vaccinated and placebo groups

*Multivariate adjustment for gender & age*

- Gender and age were not significant predictors of the HI immune antibody response (by GMT of HI antibody)
- Only the vaccination status was the independent predictor of GMT
- The HI antibody level is at a high level for at least 6 months

<table>
<thead>
<tr>
<th>Antigen</th>
<th>Group</th>
<th>Before vaccination</th>
<th>4 weeks</th>
<th>6 month</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vaccine</td>
<td>(n=127)</td>
<td>(n=127)</td>
<td>(n=124)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Vaccine</th>
<th>26.3</th>
<th>144.9</th>
<th>78.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>27.5</td>
<td>30.1</td>
<td>30.1</td>
<td></td>
</tr>
</tbody>
</table>

p value 0.633 <0.001 0.28 0.34 <0.001 0.76 0.28

<table>
<thead>
<tr>
<th></th>
<th>Vaccine</th>
<th>80.9</th>
<th>632.8</th>
<th>435</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>84.5</td>
<td>93.3</td>
<td>93.3</td>
<td></td>
</tr>
</tbody>
</table>

p value 0.830 <0.001 0.12 0.98 <0.001 0.67 0.72

<table>
<thead>
<tr>
<th></th>
<th>Vaccine</th>
<th>120.5</th>
<th>584.4</th>
<th>371</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>125.9</td>
<td>128.8</td>
<td>121.3</td>
<td></td>
</tr>
</tbody>
</table>

p value 0.489 <0.001 0.53 0.06 <0.001 0.21 0.23

*Multivariate adjustment for gender and age by 2-way ANOVA for GMT (with logGMT) with vaccination status as predictors and gender and age (60-74 versus ≥75 years) as confounders.
Unplanned hospitalizations

Can vaccination decrease hospitalizations?  
If yes, is this explained by the HI antibody response?
## Benefits of Influenza vaccination in overseas studies

<table>
<thead>
<tr>
<th>Prevents</th>
<th>elderly living in nursing homes % prevented</th>
<th>elderly in the community % prevented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia</td>
<td>46%</td>
<td>NS</td>
</tr>
<tr>
<td>Influenza</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>ILI (influenza-like illness)</td>
<td>23%</td>
<td>NS</td>
</tr>
<tr>
<td>Hospitalizations due to pneumonia or influenza</td>
<td>45%</td>
<td>26% (27%*)</td>
</tr>
<tr>
<td>Deaths from pneumonia or influenza</td>
<td>42%,</td>
<td>NS</td>
</tr>
<tr>
<td>All-cause mortality</td>
<td>60%</td>
<td>42% (47%*)</td>
</tr>
</tbody>
</table>

*after adjustment of confounders

Review of 64 Caucasians studies
Influenza is caused by a RNA virus that attacks mainly the upper respiratory tract.

**Human disease**
- Mainly caused by influenza A and B.
- Influenza A has 2 subtypes which are important for humans:
  - A(H3N2) and A(H1N1)
  - A (H3N2) - currently associated with most deaths.
## Disease burden in Hong Kong

Influenza-associated Mortality and Hospitalization in HK  

<table>
<thead>
<tr>
<th>Condition</th>
<th>Per year</th>
<th>Excess no. /100000 population 65-74</th>
<th>Excess no. /100000 population 75+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia or influenza</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COAD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ischemic HD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All cardioresp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All-cause</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumonia or influenza</td>
<td>Mortality</td>
<td>115</td>
<td></td>
</tr>
<tr>
<td>COAD</td>
<td>Mortality</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>Ischemic HD</td>
<td>Mortality</td>
<td>117</td>
<td></td>
</tr>
<tr>
<td>All cardioresp</td>
<td>Mortality</td>
<td>535</td>
<td></td>
</tr>
<tr>
<td>All-cause</td>
<td>Mortality</td>
<td>639</td>
<td></td>
</tr>
<tr>
<td>Pneumonia or influenza</td>
<td>Hospitalizations</td>
<td>58.7</td>
<td>176.3</td>
</tr>
<tr>
<td>Acute resp. ds</td>
<td>Hospitalizations</td>
<td>83.8</td>
<td>266.0</td>
</tr>
<tr>
<td>Ischemic HD</td>
<td>Hospitalizations</td>
<td>NS</td>
<td>56.4</td>
</tr>
<tr>
<td>Cerebrovas. D</td>
<td>Hospitalizations</td>
<td>NS</td>
<td>55.4</td>
</tr>
</tbody>
</table>
Prevention of Influenza

Influenza Vaccine
Prevention of influenza and its associated complications

- 40 out of 51 developed or developing countries recommend influenza vaccine for
  - elderly persons aged $\geq 60$ to 65 years (van Essen, 2000)

- US-
  - The Advisory Committee on Immunization Practices (ACIP) recommended annual influenza vaccination
    - aged 50 years old and over as well as for
    - residents of nursing homes (CDC, 2004)

- World Health Organization (WHO) recommended annual influenza vaccination to
  - persons aged $\geq 65$ years (WHO, 2002)
Antibody response of influenza vaccination in the elderly

Is the immune response of influenza vaccination good in the elderly?

Recent quantitative review (31 studies)
- in Caucasian populations in temperate regions
  (Jefferson 2005; Goodwin 2006; Gross 1997; Govert 1994)
- the antibody response is considerably lower in the elderly (17-53%) than in younger adults (70-90%)
  (Goodwin 2006)

Little information from the tropics and on non-Caucasian ethnic groups.
- None from Chinese populations nor Hong Kong
Antibody Response: PR (HI ≥ 1:40)

*High baseline % of with PR HI ≥ 1:40 in both groups*

**Seroprotection rate (HI≥40) in vaccinated and placebo groups**

<table>
<thead>
<tr>
<th>Antigen</th>
<th>Group*</th>
<th>Baseline</th>
<th>4 weeks post-vaccination</th>
<th>6 months post-vaccination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>HI ≥ 40</td>
<td>HI ≥ 40</td>
<td>HI ≥ 40</td>
</tr>
<tr>
<td></td>
<td>n=127(%)</td>
<td>n=127(%)</td>
<td>n=124(%)</td>
<td>n=124(%)</td>
</tr>
<tr>
<td>H1N1†</td>
<td>Vaccine</td>
<td>27(42.2)</td>
<td>55(85.9)</td>
<td>48(78.7)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>27(42.9)</td>
<td>27(42.9)</td>
<td>26(41.3)</td>
</tr>
<tr>
<td>p value‡</td>
<td>0.939</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>H3N2†</td>
<td>Vaccine</td>
<td>54(84.4)</td>
<td>63(98.4)</td>
<td>61(100)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>55(87.3)</td>
<td>58(92.1)</td>
<td>54(85.7)</td>
</tr>
<tr>
<td>p value‡</td>
<td>0.636</td>
<td>0.115§</td>
<td>0.003§</td>
<td></td>
</tr>
<tr>
<td>BHK†</td>
<td>Vaccine</td>
<td>63(98.4)</td>
<td>64(100)</td>
<td>61(100)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>63(100)</td>
<td>62(98.4)</td>
<td>63(100)</td>
</tr>
<tr>
<td>p value‡</td>
<td>NS§</td>
<td>NS§</td>
<td>N.S§</td>
<td></td>
</tr>
</tbody>
</table>

†H1N1: A/New Caledonia/20/99, H3N2: A/Moscow/10/99, BHK: B/Hong Kong/330/2001; ‡Chi-square statistics; §Fisher’s exact test
Seroconversion
Serological response rate
(4-fold increase vs. baseline HI titre)

<table>
<thead>
<tr>
<th>Antigen</th>
<th>Group*</th>
<th>4 weeks post-vaccination</th>
<th>6 months post-vaccination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>With ≥ 4- fold increase</td>
<td>With ≥ 4- fold increase</td>
</tr>
<tr>
<td></td>
<td>n=127 (%)</td>
<td></td>
<td>n=124 (%)</td>
</tr>
<tr>
<td>H1N1†</td>
<td>Vaccine</td>
<td>16 (25)</td>
<td>8 (13.1)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>1 (1.6)</td>
<td>0 (0)</td>
</tr>
<tr>
<td></td>
<td>p value‡</td>
<td>&lt;0.001</td>
<td>0.003§</td>
</tr>
<tr>
<td>H3N2†</td>
<td>Vaccine</td>
<td>30 (46.9)</td>
<td>18 (29.5)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>1 (1.6)</td>
<td>3 (4.8)</td>
</tr>
<tr>
<td></td>
<td>p value‡</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>BHK†</td>
<td>Vaccine</td>
<td>11 (17.2)</td>
<td>7 (11.5)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>1 (1.6)</td>
<td>0 (0)</td>
</tr>
<tr>
<td></td>
<td>p value‡</td>
<td>0.003</td>
<td>0.006§</td>
</tr>
</tbody>
</table>

†H1N1: A/New Caledonia/20/99, H3N2: A/Moscow/10/99, BHK: B/Hong Kong/330/2001
‡Chi-square statistics
§ Fisher’s exact test
Efficacy of Influenza vaccination

Many studies in Caucasian populations and temperate climate regions
- But none from the Chinese elderly nor Hong Kong

Recent review* of 64 Caucasians studies
- n=5 randomised controlled studies, n=49 cohort studies, n=10 case-control studies

Overall, influenza vaccination prevents
- deaths from pneumonia or influenza,
- pneumonia,
- hospitalizations due to pneumonia or influenza and
- all-cause mortality

Benefits
- Both in the elderly living in nursing homes and
- the community elderly (more in the former group)

Influenza Vaccination in HK
Current Practice and Recommendation

Currently, the Hong Kong SAR Government’s policy primarily provides free influenza vaccination for the

currently residents in institutions and

- i.e. Residential Care Homes for the Elderly (old age homes) over the past eight years (i.e. since 1998) and
- For elderly residents living in old aged homes, the vaccine uptake rate was reported to be over 87%.(15)

those with chronic illness

- Recent 3 years, to persons in high-risk groups such as health care workers, those with chronic illness and the disabled. (DH website, HAHO’s 2004 press release)

No free vaccination for most ambulatory community-dwelling elderly persons
Other outcomes

No significant difference between the two groups for
- ILI
- pneumonia
- mortality

(No pneumonia nor mortality in all subjects)
Influenza viral isolation in HK 2003-2004

ILI Rate (per 1,000 consultations)

No. of Isolates

2003

Month

2004

Month

6-m FU

G0PC  GP  H3N2  H1N1  B
Conclusions & Recommendation

- Influenza vaccine reduces approx. 70% of hospitalizations
  - Vaccinating 9 elderly persons would prevent 1 hospitalization
    (NNT to prevent 1 hospitalization = 9)

- 4-week A-H3N2 seroprotective antibody level (PR) explains the decrease in hospitalizations
  - The predominant virus circulating in HK was influenza A (H3N2)

Notes: 93% viral isolates were A-H3N2 (during 2004)

*Excess no. of influenza increases flu-associated hospitalizations for 65+ pop. in HK = 1882 (calculated from data reported by Wong CM, Peiris JSM, et al. sPLOS Medicine March 2006)