The Burden of Influenza in New Zealand:


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The modeling for this research was programmed by Dr. James Stanley
Outline

- Rationale
- Methods
  - Poisson Regression
- Results
- Limitations
- Future Research and Action
Sequelae from influenza infection - respiratory, neurological, and especially cardiovascular events.

Influenza may not be suspected or diagnosed.

Role of influenza is under stated in the Mortality Collection.

The rise in mortality in influenza periods has long since been recognised.
Observed weekly number of deaths due to all causes in those ≥65 years and influenza isolates in New Zealand from 1990 to 2008. Data sources: Ministry of Health Mortality Collection, ESR Weekly Virology Reports.
Methods
4 Ways to Model

Rate Difference Model

ARIMA Model
(Autoregressive Integrated Moving Averages)

Serfling Model/Cyclical Regression Model

Poisson Regression Model
Poisson Regression

- Changes in the population size using census data
- Changes in the trend in mortality over time
- Seasonality of deaths
- Respiratory Syncytial Virus isolate counts
- Influenza A and influenza B isolate counts
  (Hospital and sentinel surveillance combined)

Mortality Collection
- Respiratory and Circulatory
- All causes
- <65, ≥65, all ages
$Y_i = \alpha \exp\{\beta_0 + \beta_1(t_i) + \beta_2(t_i^2) + \beta_3[\sin(2t_i\pi/52)] + \beta_4[\cos(2t_i\pi/52)] + \beta_5[A] + \beta_6[B] + \beta_7[RSV]\}$

Previous New Zealand Study (1980-1992) –
Average 484 all-cause deaths per year
Results
<table>
<thead>
<tr>
<th></th>
<th>Respiratory and Circulatory</th>
<th>All Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;65</td>
<td>≥65</td>
</tr>
<tr>
<td>Average number of deaths (1994-2008)</td>
<td>34.5</td>
<td>310.4</td>
</tr>
<tr>
<td>Lower 95% CI</td>
<td>29.7</td>
<td>246.1</td>
</tr>
<tr>
<td>Upper 95% CI</td>
<td>39.3</td>
<td>374.7</td>
</tr>
<tr>
<td>Average mortality rate per 100,000 (1994-2008)</td>
<td>1.03</td>
<td>67.89</td>
</tr>
<tr>
<td>Lower 95% CI</td>
<td>0.89</td>
<td>54.14</td>
</tr>
<tr>
<td>Upper 95% CI</td>
<td>1.17</td>
<td>81.64</td>
</tr>
</tbody>
</table>
Influenza-associated
'Respiratory and Circulatory' deaths per 100,000 in those ≥65 years

- New Zealand 2011 Poisson: 67.9
- CDC 2010 Poisson: 66.1
- Thompson et al 2009 Poisson: 72.4
- Chow et al 2006 Poisson: 155.4
- Wong et al 2004 Poisson: 102
- Thompson et al 2003 Poisson: 98.3

Influenza-associated
'All cause' deaths per 100,000 in those ≥65 years

- New Zealand 2011 Poisson: 86.4
- Newall et al 2008 Poisson: 116.4
- Chow et al 2006 Poisson: 167.8
- Wong et al 2004 Poisson: 136.1
- Thompson et al 2003 Poisson: 132.5
Modelling versus the Mortality Collection

<table>
<thead>
<tr>
<th>Period</th>
<th>Observed Influenza-Coded Deaths</th>
<th>Poisson Model Estimates of Deaths Respiratory and Circulatory</th>
<th>Modelled Deaths/Observed Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994-1998</td>
<td>38.0</td>
<td>312.2</td>
<td>8.2</td>
</tr>
<tr>
<td>1999-2003</td>
<td>11.8</td>
<td>357.1</td>
<td>30.3</td>
</tr>
<tr>
<td>2004-2008</td>
<td>15.6</td>
<td>368.3</td>
<td>23.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Period</th>
<th>Observed Influenza-Coded Deaths</th>
<th>Poisson Modelled Estimates of Deaths All Causes</th>
<th>Modelled Deaths/Observed Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994-1998</td>
<td>38.0</td>
<td>389.0</td>
<td>10.2</td>
</tr>
<tr>
<td>1999-2003</td>
<td>11.8</td>
<td>483.0</td>
<td>40.9</td>
</tr>
<tr>
<td>2004-2008</td>
<td>15.6</td>
<td>501.6</td>
<td>32.2</td>
</tr>
</tbody>
</table>

Average annual number of observed influenza-coded deaths (ICD-9: 487.0, 487.1; ICD-10: J10.0, J10.1, J10.8, J11.0, J11.1, J11.8) in the Mortality Collection compared with average annual estimates of the number of influenza-associated deaths (Poisson model) for all ages, based on respiratory and circulatory, and all cause data for the periods 1994-1998, 1999-2003, and 2004-2008.
Influenza subtype

Influenza-associated mortality rates per 100,000 persons (respiratory and circulatory data, Poisson model) in those ≥65 years; yearly percentage of influenza isolates that were influenza A (H3N2), 1994 to 2008. Source: ESR
Influenza-associated mortality rates per 100,000 persons (respiratory and circulatory data, Poisson model) in those <65 years and ≥65 years between 1994 and 2008.
## Trends over time

<table>
<thead>
<tr>
<th></th>
<th>≥65 Years</th>
<th>All Ages</th>
<th></th>
<th>≥65 Years</th>
<th>All Ages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Respiratory and Circulatory</strong></td>
<td>Observed Mortality Rate</td>
<td>Modelled influenza-associated mortality rate</td>
<td>Observed Mortality Rate</td>
<td>Modelled influenza-associated mortality rate</td>
<td></td>
</tr>
<tr>
<td>1994-1998</td>
<td>2943.11</td>
<td><strong>65.94</strong></td>
<td>397.42</td>
<td>8.66</td>
<td></td>
</tr>
<tr>
<td>1999-2003</td>
<td>2644.84</td>
<td><strong>71.06</strong></td>
<td>364.13</td>
<td>9.46</td>
<td></td>
</tr>
<tr>
<td>2004-2008</td>
<td>2318.56</td>
<td><strong>66.66</strong></td>
<td>324.36</td>
<td>9.16</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>All causes</strong></th>
<th>Observed Mortality Rate</th>
<th>Modelled influenza-associated mortality rate</th>
<th>Observed mortality rate</th>
<th>Modelled influenza-associated mortality rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994-1998</td>
<td>4833.20</td>
<td><strong>78.99</strong></td>
<td>706.63</td>
<td>10.78</td>
</tr>
<tr>
<td>1999-2003</td>
<td>4637.68</td>
<td><strong>92.71</strong></td>
<td>689.48</td>
<td>12.78</td>
</tr>
<tr>
<td>2004-2008</td>
<td>4311.44</td>
<td><strong>87.50</strong></td>
<td>650.46</td>
<td>12.47</td>
</tr>
</tbody>
</table>

Average observed mortality rates per 100,000 persons (Mortality Collection) and average influenza-associated mortality rates (Poisson model) in those ≥65 years and in all ages based on respiratory and circulatory, and all cause data, for the periods 1994-1998, 1999-2003, and 2004-2008.
Where to now?
Limitations

- Variables
- Age groups
- Disparities
- Could these deaths really be prevented?
Future Research and Action

- Burden of disease
  Years of life lost, Hospitalisations

- Validation

- Vaccine effectiveness
  The evidence is “slim and not particularly encouraging with regard to the degree to which influenza vaccination protects elderly people against severe influenza outcomes”


- Public health measures
Thank-you

And with many thanks to Associate Professor Michael Baker and Dr. James Stanley
Questions