Systems thinking conference 2011

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Projects

Systems overview of the use of Non-pharmaceutical Interventions (NPIs) and spread of H1N1 pandemic 2009

– LA Gloria and Mexico city
– NPI use in the university student population
– NPI use in the general population of United States
RO=?

• RO is the mean number of new influenza infections created by a newly infected person in a susceptible population.
R0 = $\lambda \times P$

- $\lambda$ is human face to face contacts
- $P$ is the probability of that any given face-to-face contact will result in a new infection
- $\lambda$ and $p$ are not constants
- Both follow non-independent probability distributions
- Strategies to focus on:
  - Most socially active people
  - Most infectious people
Non-pharmaceutical Interventions (NPIs)?

- Social Distancing
- Self Isolation
- Increased hand washing
- Coughing and sneezing etiquettes
- Wearing mask when sick
- School closures
- Large public gathering places closed (like shopping malls, movie theaters etc.)
- Most extreme NPI being closing down the city eventually.
Effect of NPIs on R0

- **NPIs** can potentially reduce $\lambda$
  - $\lambda$ can be reduced by reducing the number of face-to-face contacts per day.

- **Social distancing**
  - Weekly instead of daily shopping
  - Conference calls instead of face-to-face meetings
  - In large companies even minimum desk spacing between workers

- **Self Isolation**
  - Staying home when sick, avoiding physical contact.
Effect of NPIs on R0

- **NPIs** can potentially reduce $P$
  - $P$ can be reduced
    - **Washing hands** with hot water and soap several times daily
    - **Do not shake hands** during greetings with colleagues
    - **Cough or sneeze into your elbow**, not into the open air
    - Be careful not to touch surfaces that might have recently been contaminated with flu virus.
    - Encourage your city’s large employers to stagger work hours so that public transportation subways and busses are less crowded during now-stretched-out rush hours
LA Gloria (Mexico) with no NPI use is a natural experiment (R0 = $\lambda \times \rho$)

- R0 for LA Gloria: 1.68
- La Gloria, Veracruz-Llave, Mexico
  - Population: 2,243 individuals
  - Home of “Patient Zero,” first confirmed H1N1 case
    - Edgar Hernandez, ill last week of March 2009, test confirmed April 3
    - La Gloria residents were ill as early as February 2009; many fell ill after March 21
      - They blamed the pig farm, Granjas Carroll
      - By April 2009, about 60% of the population had become sick

La Gloria residents commute to Mexico City on a weekly basis.

April 12, 2009: Easter Sunday – La Gloria residents working in Mexico City all commute back to La Gloria for the holidays despite the outbreak of flu, and all return to Mexico City for work in large numbers come the end of the holiday.
Mexico City with NPI implementation by the Govt. R0 gets affected by NPI use in Mexico city

**NPI Use Metric:**

<table>
<thead>
<tr>
<th>Type of NPI</th>
<th>April 1 to April 20</th>
<th>April 23 to May 15</th>
<th>May 15 to June 1</th>
<th>June 1 to June 15</th>
<th>June 15 to July 1</th>
<th>July 1 to July 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Distancing</td>
<td>Enforced (scattered)</td>
<td>Advised</td>
<td>None</td>
<td>None</td>
<td>Advised</td>
<td>None</td>
</tr>
<tr>
<td>School Closing</td>
<td>None</td>
<td>Enforced (Mexico City)</td>
<td>None</td>
<td>None</td>
<td>Enforced (scattered)</td>
<td>None</td>
</tr>
<tr>
<td>Hand Hygiene Isolation</td>
<td>None</td>
<td>Assisted</td>
<td>Assisted</td>
<td>Advised</td>
<td>Advised</td>
<td>Advised</td>
</tr>
<tr>
<td>Face Masks</td>
<td>None</td>
<td>Assisted</td>
<td>Advised</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Coughing Etiquette</td>
<td>None</td>
<td>None</td>
<td>Advised</td>
<td>Advised</td>
<td>Advised</td>
<td>Advised</td>
</tr>
<tr>
<td>City shutdown</td>
<td>None</td>
<td>Enforced (Mexico City)</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Time Period (days)</td>
<td>April 1 to April 20</td>
<td>April 23 to May 15</td>
<td>May 15 to June 1</td>
<td>June 1 to June 15</td>
<td>June 15 to July 1</td>
<td>July 1 to July 15</td>
</tr>
<tr>
<td>R0&amp;R(t) Values</td>
<td><strong>2.260174</strong></td>
<td>1.984268</td>
<td>1.108769</td>
<td>1.037434</td>
<td>1.036656</td>
<td>1.066359</td>
</tr>
</tbody>
</table>
To evaluate $R_0 = \lambda \times P$ in terms of NPI use

(dealing with a complex system of a spread of a pandemic and its relation to NPI use)

Two interesting projects on the H1N1 pandemic 2009 are in the progress

- 1) Use of NPIs at a university level
- 2) Use of NPIs in the general US population
NPI use in a university student population

• MIT-flu study: NPI use among MIT-students during the time of H1N1 pandemic 2009.

• Methodology:
  – Interviews (questions updates)
  – Surveys (using upgraded version of survey monkey)
    1. list of students who reported to MIT-medical with Influenza like Illness (few tested confirmed H1N1)
    2. Random selection of controls from registrar’s office (survey send to MIT-student list servers who either never reported to MIT for flu or never got the flu)

• Results: Qualitative and Quantitative data analysis using N-vivo and SPSS/STATA
<table>
<thead>
<tr>
<th>Students with ILI/flu and reported to the urgent care</th>
<th>PhD/Graduate Students</th>
<th>Business Students</th>
<th>Undergraduate Students</th>
<th>Total # of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>20</td>
<td>118</td>
<td>198</td>
<td></td>
</tr>
<tr>
<td>Students without ILI/flu</td>
<td>71</td>
<td>39</td>
<td>216</td>
<td>326</td>
</tr>
<tr>
<td>Students with ILI/flu but did not report to the urgent care</td>
<td>19</td>
<td>70</td>
<td>16</td>
<td>105</td>
</tr>
<tr>
<td>Total =</td>
<td>150</td>
<td>129</td>
<td>350</td>
<td>629</td>
</tr>
<tr>
<td>Characteristics</td>
<td>PhD Students (n=150)</td>
<td>MBA Students (n=129)</td>
<td>Undergraduate Students (n=350)</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------------</td>
<td>----------------------</td>
<td>----------------------</td>
<td>-------------------------------</td>
<td></td>
</tr>
<tr>
<td>Female sex, no. (%) of respondents</td>
<td>48(32.0)</td>
<td>59(45.7)</td>
<td>212(60.57)</td>
<td></td>
</tr>
<tr>
<td>Age, median years (range)</td>
<td>27(22-36)</td>
<td>30(26-39)</td>
<td>19(17-22)</td>
<td></td>
</tr>
<tr>
<td>Residence on campus, no. (%) of respondents</td>
<td>74(49.3)</td>
<td>33(25.5)</td>
<td>256(73.1)</td>
<td></td>
</tr>
<tr>
<td>Marital Status of the respondents, no.(%)</td>
<td>32(21.3)</td>
<td>12(9.0)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Respondents married with kids, no.(%)</td>
<td>17(53.1)</td>
<td>5(41.7)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>PanHellenic member, no.(%)</td>
<td>0</td>
<td>0</td>
<td>212(60.5)</td>
<td></td>
</tr>
</tbody>
</table>
Increased hand washing

Percentage of students

- Students without flu
- Students with flu

Increased hand sanitizer usage

Percentage of students

- Students without flu
- Students with the flu

PhD-Graduate Students  Undergraduate Students  Business Students
Social Distancing:
"did you stay away from your friends if they had the flu and avoided any physical contact with them?"

Practiced Social Distancing

Self Isolation
"Did you avoid attending any class, meeting, study discussion or dining with friends during the time you had the flu?"
Results

• significant differences in the practice among sub-population groups of the 625 student respondents with and without influenza like illness [ILI] in the use of NPI.
• MBA students reported to have practiced NPIs the least; such as, self-isolation (2%) compared to graduate students (29%) and undergraduate students (12%)
• More than seventy percent (71%) of the student respondents with ILIs continued to attend all social events, classes, and study group meetings.
• Interestingly, all student respondents without ILI were more health conscious (82%) compared to student respondents with ILI (18%)
• Identified the student sub-population that would require change in NPI implementing strategy in case of another pandemic.
System of NPI use in the general population of United States

- Data collected through knowledge networks at the time of 2009 H1N1 pandemic
- Data analysis in progress