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Control of Pandemic Influenza at Ports of Entry and in the Community - Non-Pharmaceutical Interventions (NPIs)

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Overview

- Definitions
- Background & Assumptions
- Ports of Entry Strategy
- Community Mitigation Strategy
  - Pandemic Severity Index
  - Rationale for Community Mitigation
  - Community-based Interventions
  - Initiation of Interventions (Triggers)
Definitions

- **Isolation**
  - Separation of ill persons with contagious diseases
  - Often in a hospital setting, could be at home

- **Quarantine**
  - Restriction of persons who are not ill but presumed exposed, usually in the home or a designated facility

- **Social Distancing**
  - "social measures to decrease the frequency of contact among people in order to diminish the risk of spread from communicable diseases"

- **Infection Control**
  - "hygienic measures to decrease spread of infectious pathogens"

Background & Assumptions

- **Pandemic Influenza**
  - Novel virus, fully susceptible population, efficient and sustained human to human spread
  - Epidemic over a large geographic area affecting a large proportion of the population
    - "1918-like" pandemic would result in 2 million deaths in US
  - Vaccine (pandemic strain) likely delayed
  - Antivirals may be insufficient quantity, ineffective, and/or difficult to distribute in a timely way

Ports of Entry

"The flu is now arriving at gate 4..."
Impact of Interventions at Ports of Entry

• Delay entry into US
  – 90% effectiveness = 1 week delay
  – 99% effectiveness = 3 to 4 week delay

  *Balance of benefit vs. disruption of commerce & society*

Border Interventions

• Complete Border Closure
  – Stop people & cargo

• Partial Border Closure
  – Stop people
  – Allow cargo

• Risk-based approach
  – Allow people & cargo
  – Limit entry of people based on risk

Risk Based Border Strategy, Pandemic Influenza

• Objectives
  – Identification, isolation and treatment of persons ill with infectious pandemic influenza

  – Quarantine and prophylaxis of travel contacts (in situ or home, depending on risk)

  – Ensure open ports and smooth entry into US of non-affected travelers
Pandemic Severity Index

- Designed to enable the estimation of the severity of a pandemic on a population
- Needed early in pandemic
- Mitigation interventions can be matched to the severity of the pandemic

1918
**Pandemic Severity Index**

- **Excess Mortality (Projected)**
  - Illness Rate (IR) 30%
  - Case Fatality Ratio (CFR) 2%
  - Mortality Rate: IR x CFR = 0.6%
  - Excess Mortality = MR x Population
  
  \[0.6\% \times 300,000,000 = 1,800,000\]

*To be determined early during pandemic*
Estimates of the Impact of an Influenza Pandemic by Severity

<table>
<thead>
<tr>
<th></th>
<th>Category 2</th>
<th>Category 4/5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Similar to a 1957 pandemic)</td>
<td>(Similar to a 1918 pandemic)</td>
</tr>
<tr>
<td>Illness</td>
<td>90 million (30%)</td>
<td>90 million (30%)</td>
</tr>
<tr>
<td>Outpatient medical care</td>
<td>45 million (50%)</td>
<td>45 million (50%)</td>
</tr>
<tr>
<td>Hospitalization</td>
<td>865,000</td>
<td>9,900,000</td>
</tr>
<tr>
<td>ICU care</td>
<td>128,750</td>
<td>1,485,000</td>
</tr>
<tr>
<td>Mechanical ventilation</td>
<td>64,875</td>
<td>745,500</td>
</tr>
<tr>
<td>Deaths</td>
<td>209,000</td>
<td>1,903,000</td>
</tr>
</tbody>
</table>

Community-Based Interventions

1. Delay disease transmission and outbreak peak
2. Decompress peak burden on healthcare infrastructure
3. Diminish overall cases and health impacts
Factors that Impact Transmission and Reproductive Rate (Ro)*

- Infectiousness of the infected
- Susceptibility of uninfected
- Contact rates (behaviors) in the population - target of interventions

*R_o*: avg number of persons each infected individual transmits to. Goal is R_o < 1, results in decreasing epi curve and end of outbreak/epidemic.

Basis for Use of Non-Pharmaceutical Interventions (NPIs)

- Evidence from 1918 pandemic
- Epidemiologic studies
- Modeling
- Common Sense

Menu of NPIs circa 1918

- Making influenza a reportable disease
- Isolating sick individuals
- Quarantine of households with sick individuals
- School closure
- Protective sequestration of children or adults
- Cancellation of worship services
- Closure of public gathering places [e.g., saloons, theatres, etc.]
- Staggered business hours to decrease congestion on trams, etc.

Menu of NPIs circa 1918

- Mandatory or recommended the use of masks in public
- Closing or discouraging the use of public transit systems
- Restrictions on funerals, parties, and weddings
- Restrictions on door-to-door sales
- Community-wide curfew measures and business closures
- Social distancing strategies for those encountering others
- Public health risk communication measures
- Declaration of public health emergency

Historical Data

- Review of 17 US cities, 1918 pandemic, US
- Cities that implemented multiple NPIs early in the pandemic, lower death rates
  - 50% lower peak death rate
  - 20% lower cumulative death
- Releasing NPIs early resulted in increased death rates
Supplementary tables, data and bibliography can be accessed at: www.cdc.gov/ncidod/dq/index.htm


1918 Death Rates: Philadelphia v St. Louis

<table>
<thead>
<tr>
<th>Date</th>
<th>Deaths / 100,000 Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/14/1918</td>
<td>0</td>
</tr>
<tr>
<td>9/21/1918</td>
<td>0</td>
</tr>
<tr>
<td>9/28/1918</td>
<td>0</td>
</tr>
<tr>
<td>10/5/1918</td>
<td>2</td>
</tr>
<tr>
<td>10/12/1918</td>
<td>4</td>
</tr>
<tr>
<td>10/19/1918</td>
<td>6</td>
</tr>
<tr>
<td>10/26/1918</td>
<td>8</td>
</tr>
<tr>
<td>11/2/1918</td>
<td>10</td>
</tr>
<tr>
<td>11/9/1918</td>
<td>12</td>
</tr>
<tr>
<td>11/16/1918</td>
<td>14</td>
</tr>
<tr>
<td>11/23/1918</td>
<td>16</td>
</tr>
<tr>
<td>11/30/1918</td>
<td>18</td>
</tr>
<tr>
<td>12/7/1918</td>
<td>20</td>
</tr>
<tr>
<td>12/14/1918</td>
<td>22</td>
</tr>
<tr>
<td>12/21/1918</td>
<td>24</td>
</tr>
<tr>
<td>12/28/1918</td>
<td>26</td>
</tr>
</tbody>
</table>

Liberty Loan Parade
September 28, 1918
Excess Death Rates (per 100,000) - Philadelphia

Excess Death Rates (per 100,000) - St. Louis

Excess Death Rates (per 100,000) - St. Louis

Mortality = 2X Baseline
Mortality

Markel et al. JAMA 2007  Supplementary tables, data and bibliography can be accessed at: www.cdc.gov/ncidod/dq/index.htm
**Historical Data: Markel et al, 2007**

- Review of 43 US cities, 1918 pandemic
  - Cities that implemented *multiple* NPIs, *early* in the pandemic, *longer duration*, resulted lower death rates
- Early, Sustained, Layered applications of NPIs resulted in decreased

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**EPI Data: Role of Children & Schools**

- Prevention of influenza in *children* results in decreased influenza among all age groups in the community (1).
- School closure results in decreased viral respiratory infections among children (2).
- Influenza prevention in *daycare* results in decreased influenza among household contacts (3)


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**Pandemic Influenza Illness Rates With and Without TLC Interventions**

Source: MIDAS (Imperial College- Ferguson et al.)

*All identified cases isolated, full school closure, 50% adult social contact reduction, 30%, compliance HH Quarantine, 60%, case identification*

NPI=Nonpharmaceutical intervention
Rx= antiviral treatment, Px= antiviral prophylaxis for household (HH) contacts
Who Infects Who?

<table>
<thead>
<tr>
<th>From</th>
<th>To Children</th>
<th>To Teenagers</th>
<th>To Adults</th>
<th>To Seniors</th>
<th>Total From</th>
</tr>
</thead>
<tbody>
<tr>
<td>From Children</td>
<td>21.1</td>
<td>3.0</td>
<td>12.2</td>
<td>1.6</td>
<td>43.4</td>
</tr>
<tr>
<td>From Teenagers</td>
<td>2.4</td>
<td>19.3</td>
<td>6.1</td>
<td>6.7</td>
<td>28.9</td>
</tr>
<tr>
<td>From Adults</td>
<td>4.6</td>
<td>6.2</td>
<td>12.5</td>
<td>1.8</td>
<td>31.8</td>
</tr>
<tr>
<td>From Seniors</td>
<td>0.2</td>
<td>0.4</td>
<td>0.8</td>
<td>5.7</td>
<td>8.2</td>
</tr>
<tr>
<td>Total To</td>
<td>20.6</td>
<td>16.6</td>
<td>49.6</td>
<td>5.7</td>
<td>92.5</td>
</tr>
</tbody>
</table>

Likely sites of transmission
- School
- Household
- Workplace

Demographics
- Children/Teenagers: 29%
- Adults: 59%
- Seniors: 12%

*Based on avg. 2,600 sq. ft. per single family home


Spacing of people: If homes were like schools

*Based on avg. 3,000 sq. ft. per single family home

CDC
Spacing of people: If homes were like schools

*Based on avg. 2,600 sq.ft. per single family home

Social Density

http://buildingsdatabook.eren.doe.gov/docs/7.4.4.xls

Community Strategy

- Isolation and treatment of ill persons
- Voluntary home quarantine of household contacts
- Dismissal of students from school and social distancing and daycare closure
- Workplace/community social distancing

Targeted Layered Containment (TLC):
The sum likely to be greater than the parts...
### Other Infection Control Measures

- All interventions should be used in combination with other infection control measures including **hand hygiene, cough etiquette, and personal protective equipment such as face masks.**

- Additional information on infection control measures is available at [www.pandemicflu.gov](http://www.pandemicflu.gov).

### Community Strategies by Pandemic Flu Severity (1)

<table>
<thead>
<tr>
<th>Interventions by Setting</th>
<th>Pandemic Severity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>Home</strong></td>
<td></td>
</tr>
<tr>
<td>Voluntary isolation of ill at home (adults and children); combine with use of oseltamivir treatment as available and indicated</td>
<td>Recommend</td>
</tr>
<tr>
<td>Voluntary quarantine of household members in homes with ill persons (adults and children); consider combining with antiviral prophylaxis if effective, feasible, and quantities sufficient</td>
<td>Generally not recommended</td>
</tr>
<tr>
<td><strong>School</strong></td>
<td></td>
</tr>
<tr>
<td>Child social distancing</td>
<td></td>
</tr>
<tr>
<td>- dismissal of students from schools and school-based activities, and closure of child care programs</td>
<td>Generally not recommended</td>
</tr>
</tbody>
</table>

### Community Strategies by Pandemic Flu Severity (2)

<table>
<thead>
<tr>
<th>Interventions by Setting</th>
<th>Pandemic Severity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>Workplace/Community</strong></td>
<td></td>
</tr>
<tr>
<td>Adult social distancing</td>
<td></td>
</tr>
<tr>
<td>- decrease number of social contacts (e.g., encourage teleconferences, alternatives to face-to-face meetings)</td>
<td>Generally not recommended</td>
</tr>
<tr>
<td>- increase distance between persons (e.g., reduce density in public transit, workplace)</td>
<td>Generally not recommended</td>
</tr>
<tr>
<td>- modify, postpone, or cancel selected public gatherings to promote social distance (e.g., stadium events, theater performances)</td>
<td>Generally not recommended</td>
</tr>
<tr>
<td>- modify workplace schedules and practices (e.g., telework, staggered shifts)</td>
<td>Generally not recommended</td>
</tr>
</tbody>
</table>
Triggers

- Timing of initiating interventions influences effectiveness
  - Historical evidence from 1918 pandemic
  - Models
  - Common sense
Triggers for Implementation of Mitigation Strategies by Pandemic Severity Index and U.S. Government Pandemic Stages

<table>
<thead>
<tr>
<th>Pandemic Severity Index</th>
<th>WHO Phase 6, U.S. Government Stage 3†</th>
<th>WHO Phase 6, U.S. Government Stage 4† and First human case in United States</th>
<th>WHO Phase 6, U.S. Government Stage 5† and First laboratory-confirmed cluster in State or region¶</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Alert</td>
<td>Standby</td>
<td>Activate</td>
</tr>
<tr>
<td>2 and 3</td>
<td>Alert</td>
<td>Standby</td>
<td>Activate</td>
</tr>
<tr>
<td>4 and 5</td>
<td>Standby††</td>
<td>Standby/Activate ††</td>
<td>Activate</td>
</tr>
</tbody>
</table>

Community Mitigation: Consequences

- Economic impact and potential disruption of services due to absenteeism
- Issues associated with sequestration of children
- Disproportionate impact on certain populations
- Shifts medical care from community to home

These and other consequences may occur in the absence of community-wide interventions, as a result of spontaneous action by the public.

Summary

- Risk Based Border Strategy may be effective in delaying introduction of pandemic influenza
- Community Nonpharmaceutical interventions (NPIs) likely to be effective in mitigating influenza pandemic
  - Effectiveness unknown, will depend on compliance with interventions
  - Multiple, early interventions (targeted, layered containment) likely more effective than single intervention
  - Consequences of interventions need to be considered
  - May be the only interventions available for resource poor countries
  - Additional research needed
“You make policy based on the data you have, not the data you wish you had…”

- Adapted from a former Secretary of Defense