How to Prepare for Workforce Continuity and Business Operations in the Upcoming Flu Season

September 10, 2015
Status: MERS, Saudi Arabia, Korea and more
Flu H5N1
Flu H9N7
Each a Major Threat to Us All!

Richard C. Larson
Mitsui Professor
Data, Systems, and Society
How to Prepare for Workforce Continuity and Business Operations in the Upcoming Flu Season

*It’s Nothing to Sneeze At!*
We are Live from MIT!
Think of disasters and disaster recovery...

• Computer system crashes and hacking
• Internet down
• Floods
• Fires
• Explosion
• No electricity

How about: 40% of your workforce unable to go to your workplace?
STOP
the spread of the flu!

1. WASH HANDS
2. COVER COUGHS
3. STAY HOME (if sick)

Sarasota County
Health Department
sarasotahahealth.org
Serious new respiratory infectious diseases continue to appear and evolve, creating the possibility of deadly global pandemic.

- MERS (Middle East Respiratory Syndrome, >30% fatality rate, started in Saudi Arabia, 1,244 cases (WHO data), with at least 446 related deaths).
- H5N1 (bird flu, 60% case fatality rate, Southeast Asia; CDC mishandling of this & more),
- H7N9 (bird flu, 25% fatality rate, China)
June 6, 2015: A couple's wedding photo shows the dark reality of Korea's MERS situation.
While none of these illnesses currently show ease of transmission from person-to-person, recent MIT-based research indicates that just one or two possible mutations could turn H5N9 and/or H7N9 into a pandemic-causing virus.

Less is currently known about MERS, but both the World Health Organization (WHO) and the U.S. Centers for Disease Control (CDC) are quite concerned about MERS.
Main factors contributing to the spread of MERS in the Republic of Korea were:
• Lack of awareness among health care workers and the general public about MERS
• Suboptimal infection prevention and control measures in hospitals
• Close and prolonged contact of infected MERS patients in crowded emergency rooms and multi-bed rooms in hospitals
• The practice of seeking care at multiple hospitals ("doctor shopping")
• The custom of many visitors or family members staying with infected patients in the hospital rooms facilitating secondary spread of infections among contacts.
MERS Outbreak Hits South Korea Economy, GDP Growth At 6-Year Low

By Sneha Shankar (@SnehaShankar30) on July 23 2015 6:24 AM EDT

- Store sales plunged y/y over 17% in June
- Amusement discretionary activities down 38% to 82% y/y
- In June over 125,000 foreign tourists cancelled trips
- Foreign travelers who signed up to visit South Korea in July and August is down 82% y/y.
- South Korea to spend $9bn to counter MERS impact, mostly to 'embattled' service sector.
From anthrax to bird flu – the dangers of lax security in disease-control labs

A series of security failures in US disease-control labs handling lethal bugs such as anthrax, smallpox and bird flu has raised questions about the dangers of research into deadly pathogens

Ian Sample
Follow @iansample Follow @guardian

The Guardian, Friday 18 July 2014 14.26 EDT

Testing for the H5N1 bird flu virus ... in the US, labs at the Centres for Disease Control (CDC) have seen a series of security lapses and contaminations in recent months. Photograph: Danny Lawson/PA
Feedback....

• How many of you have included flu pandemic or equivalent serious respiratory infection as part of your Crisis Management & Business Continuity Plan?
We Often Plan Based on Past “Anchored Events”

- 1918 ‘Spanish’ Flu, Boston was urban epicenter

Boston 1918: What do many Bostonians think of that year?
1918 - 1919 “Spanish Flu”

Emergency Hospital, Camp Funston, Kansas, Photo Courtesy of National Museum of Health and Medicine, Armed Forces Institute of Pathology
Flu Timeline

Normal Influenza Rates

Precursor Wave, Low Virulence (spring of 1918)

Main Wave, High Virulence (fall of 1918)

Second Wave (early in 1919)

Return to Normalcy
FIGURE 1-2 Influenza and pneumonia mortality by age, United States. Influenza and pneumonia specific mortality by age, including an average of the interpandemic years 1911–1915 (dashed line), and the pandemic year 1918 (solid line). Specific death rate is per 100,000 of the population in each age division. SOURCES: U.S. Department of Commerce (1976); Grove and Hetzel (1968); Linder and Grove (1943).
Historical Impact (Mortality)

- 1918 Spanish Flu (in perspective)
Then There were Pigs
And, about 72 months ago, we found ourselves living with Novel H1N1 “Swine Flu”
• H1N1 is Here!
The H1N1 Pandemic Scare

- Initial overestimation of the fatality rate
  - Mexico reported about 2,400 cases and 150 deaths
  - 6% death rate approached that of SARS
    - Denominator was too small and the numerator was too large due to inaccurate reports of the number of cases.

Measure: Death Rate of H1N1

- Rigorous tracking of H1N1 cases
- The 2009 A/H1N1 Pandemic begins
Goal: Focus on NPI’s, Non-Pharmaceutical Interventions

- Improve the Pandemic Preparedness & Response system.
  - National
  - State
  - City
  - Business (Educate that much control is in our hands! Via NPI’s Non-Pharmaceutical Interventions)
  - Family
  - Individual levels

- Develop improved procedures for analyzing and creating Pandemic Preparedness & Response plans.
SARS, 2003
NPI’s: We Can Learn from SARS
Hong Kong Results: Other Respiratory Infections

- To reduce risk of SARS infection, residents radically altered social behavior, both hygienic behavior & social distancing.
  - 76% of the population wore masks,
  - 65% washed their hands after contact with potentially contaminated objects,
  - 78% covered their mouths when sneezing or coughing and
  - >50% used diluted bleach for household cleaning.

- Social distancing steps: closings of schools, libraries, swimming pools and Kowloon Bay Sports Center.

- Sharp reduction in many discretionary activities such as attending social events, shopping & going to restaurants.
Hong Kong Results: Other Respiratory Infections

- The SARS epidemic was stopped.
- “What were the beneficial effects of the population’s hygienic steps & social distancing?”
- Incidence of other acute respiratory viral diseases during the key months April and May 2003 dropped 90% compared to seasonal norms. (seasonal influenza, parainfluenza, respiratory syncytial virus, & adenovirus).
- This is best evidence that behavioral modifications can dramatically reduce the spread of respiratory infections.
- Any modeling analysis that ignores behavioral changes removes our greatest disease-progression control strategies.
Lessons from History

• In the past human behavior and social heterogeneity affected infection transmission

• Social distancing and improved hygiene can significantly decrease the prevalence of the virus
Modeling Flu Progression 1: 
$R_0$ & Effects of Heterogeneities
Modeling Flu Progression 1:
\( R_0 \) & Effects of Heterogeneities
Mathematical Models
### Heterogeneity of Social and Professional Contacts (Fu)

<table>
<thead>
<tr>
<th>Number of daily contacts</th>
<th>Number of respondents</th>
<th>Percent of respondents</th>
<th>Cumulative percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–4</td>
<td>410</td>
<td>13.67</td>
<td>13.67</td>
</tr>
<tr>
<td>5–9</td>
<td>426</td>
<td>14.20</td>
<td>27.87</td>
</tr>
<tr>
<td>10–19</td>
<td>685</td>
<td>22.83</td>
<td>50.70</td>
</tr>
<tr>
<td>20–49</td>
<td>792</td>
<td>26.40</td>
<td>77.10</td>
</tr>
<tr>
<td>50–99</td>
<td>349</td>
<td>11.63</td>
<td>88.73</td>
</tr>
<tr>
<td>100+</td>
<td>338</td>
<td>11.27</td>
<td>100.00</td>
</tr>
<tr>
<td>Totals</td>
<td>3,000</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>
Flu Fundamentals:

\( R_0 = \) Mean Number of New Infections Caused by a Newly Infected Person

“Basic Reproductive Number”
Flu Fundamentals:

$$R_0 = \lambda p$$

$\lambda =$ frequency of daily contacts ("lambda")

$p =$ probability of transmitting infection, given contact
For your business, let’s talk about $\lambda$
For your business, let’s talk about p
Let’s talk about the probability distribution whose mean is $R_0$. 
Workplace Images

GET YOUR FLU SHOT!
Feedback...

• Do you have these types of steps incorporated in your company’s flu preparedness and response plan?
Key Points

• Within the context of attempted social controls, the generation-to-generation ‘reproductive number’ should be viewed as an outcome of human behavior, not an input.

• The product $\lambda_j p_j$ is the primary determining factor associated with disease spread associated with that subpopulation.

• Public policies to control the disease may best be devoted to those groups having highest values of the product $\lambda_j p_j$.

• “Early separation” is better!
Karima’s Ph.D. Thesis:
Modeling and Responding to Pandemic Influenza:
Importance of Population Distributional Attributes and
Non-Pharmaceutical Interventions
This video lesson shows students that math can play a role in understanding how an infectious disease spreads and how it can be controlled. During this lesson, students will see and use both deterministic and probabilistic models and will learn by doing through role-playing exercises. There are no formal prerequisites, as students in any high school or even middle school math class could enjoy this learning video. But more advanced classes can go into the optional applied probability modeling that accompanies the module in a downloadable pdf file. Materials needed for the lesson include paper or cardboard, plus scissors and tape or staples, for making green, red and blue-colored hats for each student. These supplies are also needed for making numbers to draw out of a hat. The primary exercises between video segments of this lesson are class-intensive simulation games in which members of the class 'infect' each other under alternative math modeling assumptions about disease progression. Also there is an occasional class discussion and local discussion with nearby classmates.

**Online Animations**, visit the Accompanying Online Animations for a selection of animations and/or simulations designed in coordination with the BLOSSOMS video flu games and intended to supplement the ideas covered in the BLOSSOMS module. These resources were developed by e-Learning Arabia.

- Simulation 1: Exponential Growth, Sampling without Replacement
- Simulation 2: Sampling with Replacement
- Simulation 3: Super Spreaders
- Simulation 4: R0 =1.5
- Simulation 5: Initial Immunity
- Simulation 6: Statistical Flu Spread Simulation Too

This Lesson is in the following clusters: Health
Vaccine Distribution in the US

• The CDC started shipping vaccines in early October 2009

Measure: Number of Weeks Before Peak that Vaccines are Shipped

- 1 week after peak
- At peak
- 1 week before peak
- Between 2 and 4 weeks before peak
- > 4 weeks before peak
H1N1 Vaccine Administration

Comparison of US, GA, and ME Epidemic Curves

First vaccine shipped, Week 40

Week Ending October 10

<table>
<thead>
<tr>
<th># Of States Peaking...</th>
<th>Week 39 or earlier</th>
<th>Week 40 or earlier</th>
<th>Week 41 or earlier</th>
<th>Week 42 or earlier</th>
<th>Week 43 or earlier</th>
<th>Week 44 or earlier</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>10</td>
<td>14</td>
<td>24</td>
<td>34</td>
<td>40</td>
<td>44</td>
</tr>
</tbody>
</table>

Typical Example: Indiana

- Administration of vaccine lags shipment
- Vaccine effectiveness lags administration
  ➔ Few are protected in time to affect epidemic
Latest Research Result

• A new way for the CDC to deploy flu vaccines.
• Would have prevented over 5,000,000 H1N1 infections.
Social Distancing for Firms

• Social Distancing is the Key to Flu Infection in Your Business.

• Protect yourself and your staff: Minimize or eliminate close contact and proximity to others.

• Second is frequent hand washing.
Social Distancing for Firms

Ways you can encourage social distancing in the workplace.

- Avoid crowded places and large gatherings of people, whether in internal or external spaces.
- A distance of at least one meter should be maintained between persons wherever practical. Larger distances are more effective.
- Visiting of, or other contact with, unwell people should be avoided.
- Avoid meeting people face-to-face, use the telephone, video conferencing and the internet to conduct business as much as possible, even when participants are in the same building.
- Avoid handshaking and any other greeting which involves person-to-person contact.
Social Distancing for Firms

• Avoid any unnecessary travel and cancel or postpone non-essential meetings.
• If possible, arrange for employees to work from home or work variable hours to avoid crowding at the workplace.
• Practice 'ghost' shift changes wherever possible, with the shift going off duty leaving the workplace before the new shift enters. If possible, leave an interval before re-occupation of the workplace. If possible, thoroughly ventilate the workplace between shifts by opening doors and windows or turning up the air-conditioning.
Social Distancing for Firms

- Avoid public transport. Walk, cycle, drive a car or go early or late to avoid rush hour crowding on public transport.
- Bring lunch and eat at desk or away from others.
- Avoid the cafeteria and crowded restaurants.
- If a face-to-face meeting with people is unavoidable, minimize the meeting time, choose a large meeting room and sit at least one meter away from each other if possible, avoid shaking hands or hugging.
- Encourage staff to avoid recreational or other leisure classes, meetings etc. where they might come into contact with infectious people.
Maybe Some “Constraints” Can be Adjusted or Removed (Boston 1918)

• Subways, Trolleys and Buses – Windows Open
• Staggered Work Hours…..
What To Do at Home (posted):

REVIEW ARTICLE
A Home Toolkit for Primary Prevention of Influenza by Individuals and Families
Stan Finkelstein, MD; Shiva Prakash, MCP; Karima Nigmatulina, PhD; James McDevitt, PhD; Richard Larson, PhD

Disaster Medicine and Public Health Preparedness
©2011 American Medical Association. All rights reserved.
Random Reflections on H1N1

- Vaccine was sold as the cure when it wasn’t.
- Social distancing, hand-washing and cough/sneeze etiquette have taken hold in many places.
- H1N1 was less lethal than average seasonal flu. Dress rehearsal for a real thing.
- There were millions of surplus flu vaccine doses.
Engineering Effective Responses to Influenza Outbreaks

Stan N. Finkelstein
Engineering Systems Division, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139; and Harvard Medical School, Boston, Massachusetts 02115, snf@mit.edu

Richard C. Larson
Engineering Systems Division, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, rclarson@mit.edu

Karima Nigmatulina
Institute of Master Planning for the City of Moscow, Moscow 125047, Russia knigmatulina@genplanmos.ru

Anna Teytelman
Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, teytanna@gmail.com
Thank You!

Richard C. Larson
<rclarson@mit.edu>