BioDiaspora
Evidence-Based Decision-Making

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Globalization

- Population growth
- Urbanization
- Mass gatherings
- Human-animal interactions
- Climate change
International Spread of SARS

Probability of Importation by Network Distance from Hong Kong

- **Direct**
  - 40%

- **One Stop**
  - 1.7%

- **≥ Two Stops**
  - 0%

Network Distance from Hong Kong International Airport

Confirmed-Probable SARS
Predicting the Wave of a Pandemic
Risk vs Risk Perception

- Uncertainty in absence of good evidence
- Time sensitive decisions
- Public and political pressure
- Risk for counterproductive actions
International Health Regulations

“...prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks, and which avoid unnecessary interference with international traffic and trade”.

Purpose and Scope (Article 2)
Introduction

Kamran Khan,a Rose Eckhardt,b John S Brownstein,c Raza Naqvi,d Wei Hu,b David Kossowsky,b David Scales,e Julien Arino,f Michael MacDonald,g Jun Wang,b Jennifer Searsb & Martin S Cetronh

Objective To evaluate the screening measures that would have been required to assess all travellers at risk of transporting A(H1N1)pdm09 out of Mexico by air at the start of the 2009 pandemic.

Methods Data from flight itineraries for travellers who flew from Mexico were used to estimate the number of international airports where health screening measures would have been needed, and the number of travellers who would have had to be screened, to assess all air travellers who could have transported the H1N1 influenza virus out of Mexico during the initial stages of the 2009 A(H1N1) pandemic.

Findings Exit screening at 36 airports in Mexico, or entry screening of travellers arriving on direct flights from Mexico at 82 airports in 26 other countries, would have resulted in the assessment of all air travellers at risk of transporting A(H1N1)pdm09 out of Mexico at the start of the pandemic. Entry screening of 116 travellers arriving from Mexico by direct or connecting flights would have been necessary for every one traveller at risk of transporting A(H1N1)pdm09. Screening at just eight airports would have resulted in the assessment of 90% of all air travellers at risk of transporting A(H1N1)pdm09 out of Mexico in the early stages of the pandemic.

Conclusion During the earliest stages of the A(H1N1) pandemic, most public health benefits potentially attainable through the screening of air travellers could have been achieved by screening travellers at only eight airports.
“Basic Anatomy”

- **Population in At-Risk Area**
  - Exit Screening
  - Targeted Entry Screening
  - Indiscriminate Entry Screening

- **Airport in At-Risk Area**
  - Flights Departing At-Risk Area
  - Airport with Direct Connection
  - Flights Departing Connecting Airport

- **Flights from Low-Risk Areas**
  - Airport without Direct Connection

**Travelers**
- With disease
- With latent infection
- Not infected from at-risk area
- Not infected from low-risk areas
interventions with “reasonable” public health returns from those that should be considered unnecessary because they are minimally effective and excessively disruptive to traffic and trade. 19 The results of our analyses of the patterns of global air traffic during a real pandemic indicate that the indiscriminate entry screening of travellers on international flights would be highly disruptive, inefficient and impractical. Compared with exit screening in areas at risk, indiscriminate entry screening could be marginally more effective but would be vastly more inefficient because the cohort to be screened would comprise at-risk travellers within a much larger pool of low-risk travellers from areas of the world with little or no epidemic activity. According to our criteria, just 0.11% and 0.07% of all air travellers who arrived, in April and May of 2009, respectively, at international airports on international flights that did not originate in Mexico would have been at risk of infection with A(H1N1)pdm09.

Table 2. Characteristics of the health screening strategies that might have been used to detect A(H1N1) pandemic influenza in travellers in May 2009

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exit</td>
</tr>
<tr>
<td>No. of cities where screening would have been required</td>
<td>35</td>
</tr>
<tr>
<td>No. of low-risk travellers who would have had to be screened d</td>
<td>6017</td>
</tr>
<tr>
<td>No. of travellers who would have had to be screened for every at-risk traveller d</td>
<td>1.01</td>
</tr>
<tr>
<td>No. of travel hours until screening</td>
<td>Median (interquartile range)</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
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</table>

a The data come from modelled scenarios in which the theoretical aim was to prevent air travellers carrying A(H1N1)pdm09 out of Mexico in May 2009.
b The screening of travellers on international flights arriving directly from Mexico.
c The screening of travellers on international flights arriving from any international airport worldwide.
d The 583 774 air travellers who initiated international travel from any domestic or international airport in Mexico in May 2009 were considered “at-risk” while all other travellers were considered “low-risk”.
Mexico: Int’l Departures

Proportion of All International Travelers Departing Mexico

Number of Mexican Airports Operating International Flights

- Mexico City
- Cancun
- Guadalajara
- Puerto Vallarta
- Monterrey
New Infections During Travel

- Theoretical advantage to entry screening
- Transition of latent infections to active disease
- Flight duration vs incubation period
International Travel Time

For most pathogens, the probability of transition from latent infection to symptomatic disease during air travel is very low.
Figure 3: International Flights Departing Mexico* and Corresponding Travel Times, May 2009

* 82 international cities received flights directly from Mexico in May 2009
First Proof – 12.114777

at least in the short-term, the benefits of exit screening in any country with an epidemic source control and timely and defensible decisions about midable challenge of making rational, authoritative confronted with the for-

a decision-support tool for national retrospective evaluation, we developed 

disease, as a supplement to a robust, sustainable, then targeted entry screening 

ties to the a 

demic – particularly those with strong 

by the pathogen producing the ep-

Other countries that are currently una 

realities should create incentives for 

Note: As a supplement to exit screening, targeted entry screening might be useful for pathogens with 

Fig. 5. 

Evidence-based decision-support tool for cities at risk of the importation of a pathogen causing infectious disease

Global area(s) with community-based epidemic activity

Effective exit screening implemented?

Yes

No

Non-stop flights arriving directly from affected area?

Yes

No

Infectious agent with short incubation period?

Yes

No

Evaluate role of entry screening

Screening of travellers not suggested

Evaluate role of entry screening

Screening of travellers not suggested

Heighten local infectious disease surveillance and mobilize resources for public-health control
Key Messages

• **IF screening is considered**
  
  • Exit screening most efficient, least disruptive but places further burden on source country
  
  • Entry screening in cities receiving direct flights from source area a second but less desirable option
  
  • Entry screening in cities not receiving direct flights from source area highly inefficient & disruptive
  
  • 90% of all potential public health benefits from H1N1 health screening obtainable at just eight airports
Prospective Risk Assessments

Timely
Accessible
Predictive
Shareable
Customizable
Bio Diaspora
Scattering of Life
To understand how the interactions of living systems in an increasingly globalized world impact human health, security, and prosperity.

The Mission
Humans
Animals
Insects
Microbes
Environment
Transportation

BioDiaspora Servers

Predictive Analytics
Generated in Real-Time
Remotely Accessible
Anywhere Anytime
Customized To
Space, Time, Pathogen

End User
End User
End User
End User
End User
End User
End User
End User
End User
End User
End User

RAW DATA

DECISION MAKERS
Anticipating Impact

Pathogen

Population  Environment

Countermeasures
Rapid Risk Assessment
Suspected or Confirmed Infectious Disease Threats

SOURCE DESTINATIONS

Pathogen
ONE SOURCE
Population Environment

Transportation

Pathogen
MANY DESTINATIONS
Population Environment
Domestic Air Travel within China from Shanghai, Hangzhou, Nanjing, and Wuxi (April - June) With Poultry Density
Passenger Volumes to US & Canada from Shanghai, Hangzhou, Nanjing, and Wuxi (April - June)

With Chinese-Born Population by County and Direct Flights from Shanghai

- Vancouver: 16,664 passengers
- San Francisco: 20,653 passengers
- Los Angeles: 27,204 passengers
- Chicago: 14,295 passengers
- New York: 27,565 passengers
- Toronto: 14,007 passengers

**Chinese-Born US Population By County**
- 1,000 - 10,000
- 10,001 - 100,000
- > 100,000

**Direct Flights from Shanghai**
- 1,000 - 2,500
- 2,501 - 5,000
- 5,001 - 10,000
- > 10,000

Travel from Shanghai and Neighboring Provinces

Neighboring Provinces of Shanghai include Jiangsu, Zhejiang, Anhui, and Henan.

Data Source: IATA 2010, WHO 2013
Travel from Beijing, and Shanghai and Neighboring Provinces
Neighboring Provinces of Shanghai include Jiangsu, Zhejiang, Anhui, and Henan
Travel from Hong Kong, Beijing, and Shanghai and Neighboring Provinces

Neighboring Provinces of Shanghai include Jiangsu, Zhejiang, Anhui, and Henan
Local Risk Anticipation
Scheduled Events such as International Mass Gatherings

Pathogen
Population Environment

MANY SOURCES
Population Environment

Transportation

Pathogen
Population Environment

ONE DESTINATION
Internet-Based Disease Surveillance

Potential Informal Electronic Data Sources:

- SMS Messaging
- Emailing
- Microblogging
- Internet searching
- Social networking
- Internet chatting
- Blogging
- Online news reporting
- Video/radio news reporting
- Health expert reporting
London Olympics 2012
Integrated Global Epidemic Surveillance & Transportation Modelling
“Proclaim the Pilgrimage to all people. They will come to you on foot and on every kind of swift mount, emerging from every deep mountain pass.”

Qur’an
Chapter 22 verse 27
Pilgrims Performing Hajj
From 1932 to 2011

- 62% Domestic
- 38% Foreign

Total Pilgrims Performing Hajj

- 1932: 0
- 1935: 0
- 1940: 0
- 1945: 0
- 1950: 0
- 1955: 0
- 1960: 0
- 1970: 0
- 1975: 0
- 1980: 0
- 1985: 0
- 1990: 0
- 1995: 0
- 2000: 0
- 2005: 0
- 2010: 2,900,000
- 2011: 3,000,000

WWII
Global Risk Anticipation
Unknown or Unrecognized Infectious Disease Threats

MANY SOURCES
Pathogen
Population
Environment

Transportation

MANY DESTINATIONS
Pathogen
Population
Environment
HUMANS

INSECTS

MICROBES

ANIMALS

ENVIRONMENT

TRANSPORTATION
Artificial Intelligence

- Identify local convergence of global risks
- For every major pathogen
- For every geography in the world
- Around the clock 24-7-365
- Foundation for global forecasting system
Need for Global Forecasting

- West Nile into USA (1990)
- Not Much Happened (1990)
- SARS Epidemic (2000)
- Chikungunya in Italy (2000)
- Cholera in Haiti (2010)
- H1N1 Pandemic (2010)
- ??? (2020)
- H7N9 in China (2020)
- NCoV in Middle East (2020)
Conclusions
Use Data to Your Benefit

- BioDiaspora designed to facilitate integration and synthesis of information
- Capability to support time-sensitive evidence-based decisions
- Integration of public or private data
Collaboration

- Current work with CDC, PHAC, ECDC
- Seeking partners in aviation & health
- Early adopters and testers
- Planning and emergency response
THANK YOU

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