Influenza seasonal patterns in the tropical areas
Methods

Classification of countries:
- Countries with 1 peak a year
- Countries with 2 peaks a year
- Countries with 3 peaks a year
- Countries with no/irregular pattern
- Countries with no/not enough data for time series analysis
Example country with 1 peak a year

Indicates significant correlation between time points 1 year apart
Example country with 2 peaks a year
Example country with 3 peaks a year
Example country with no/irregular pattern
Example country with not enough data
Countries showing peak influenza activity in the three month period

The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.
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Preliminary comments

- Influenza seasonality appears to exist in some tropical zones but not all
  - Less evident than that observed in temperate climate zones

- Paucity of data in most tropical areas
  - South America has the most complete data

- Need data for time series analysis
Current understanding of influenza seasonality

“Infectious disease dynamics offer a wide variety of intriguing and unexplained phenomena, yet none is as consistently observed while still remaining so poorly understood as the seasonality of influenza”

Lofgren et al (2007)
Influenza Seasonality: Underlying Causes and Modeling Theories
Seasonality of influenza is a conundrum across latitudes

- All hospital and community-based studies using one or more laboratory tests, with a minimum average of 2 virus-positive specimens per month.

Bloom-Feshbach *et al.* (2013). PLoS ONE 8(2)
Influenza in the Americas

Influenza in Tropical regions
Viboud et al Plos medicine April 2006
Putative pathways of transmission

- SNEEZES
- COUGHS
- NASAL FLUIDS
- SALIVATION

AIRBORNE TRANSPORT
- droplets & aerosols
  - >10-20 μm Ø
  - <5 μm Ø

INHALATION

DEPOSITION

SELF INNOCULATION

SURFACE CONTACT

INTERMEDIATE OBJECTS
- dependent upon porosity

KONBPAL

SELF

INNOCULATION
Putative relationship and causal connections among key seasonal stimuli, mediating mechanisms, and influenza epidemics.
Mediating mechanisms

Seasonal stimuli
- Humidity
- Solar Radiation
- Temperature
- Precipitation
- Socio-Behavior

Mediating mechanisms
- Virus Survival
- Immunity
- Contact Rate

Epidemic (R)
Influenza seasonality

Seasonal stimuli
- Humidity
- Solar Radiation
- Temperature
- Nutrition (Vitamins C, D, E, selenium, etc)
- Precipitation
- Socio-Behavior

Mediating mechanisms
- Virus Survival
- Immunity
- Contact Rate

Relative Humidity
- Virus survival
- Shuman & Kohn 2009
- Shaman et al. 2010
- Plos biology February 23, 2010

Absolute Humidity

would explain better current data better
Shaman & Kohn 2009
Shaman et al. 2010
Plos biology February 23, 2010

Hemmers et al. 1962
Harper G 1961
Hood 1963
Loosli et al. 1943
Relative Humidity

Problem:
- Does not explain circulation in the tropics
Sensitivity of influenza viruses to UV radiation
(Tamm and Fluke 1950, Powell and Setlow 1956, Jensen 1964)

Low inactivation rates during low sun seasons
Sagripanti and Lytle 2007

Problem:
- Little UV indoors (where a large proportion of influenza transmission possibly occurs)
Vitamin D (dependent upon exposure to UVB) acts as an immune system modulator (Canel et al 2006)

Clinical trial (Urashima et al 2009): Tested if vitamin D supplements affected the incidence of influenza in school-aged children.

Yes for Influenza A (and Asthma) but No for Influenza B
Problems:

- Still poor evidence
- It might act as a facilitator, but would still need additional mechanisms to explain why changes in weather trigger epidemics
Influenza seasonality

Problem:
- Hard to explain circulation in the tropics

Virus stability

Temperature (21°C)

Polozov et al 2008
Cold winter weather causes people to crowd indoors

(one of the most accepted hypothesis)
Individuals spend on average 1–2 hours more indoors during cold weather in the USA (Graham and McCurdy 2004)
It would also be valid for precipitation, as people spend about 0.5 hours more indoors during rainy weather conditions.
Problems:
- These differences seem minimal in the 24 hours of the day (mainly in the current crowded conditions of urban areas)
- No empirical data has shown an association between increased contact rates due to weather conditions and increases in influenza transmission (Lofgren et al. 2007)
School schedules, calendar festivities, etc could drive influenza

Holidays reduced transmission among children in France by 20–29% (Cauchemez et al. 2008)
Problems:
- Influenza peaks during the winter in temperate locations, and not during the fall or spring (when children are also in school)
- Tropical epidemics do not overlap with school calendar
- Crowding also occurs year-round at festivals, sporting events, and conferences without consistent outbreaks of infection
Exposure to cool (and dry) temperatures can affect host immunity:
- vasoconstriction in the nose and respiratory tract (Le Merre et al. 1996)
- mucociliary function (Salah et al. 1988)
- increases energetic demand (Lochmiller and Deerenberg 2000)
- abrupt changes in temperature are also implied in a broad range of diseases, including influenza (Bull and Morton, 1978)
Problems:
- Hard to explain circulation in the tropics
Recommendation of optimization of influenza vaccination in Brazil as a by-product of the studies of influenza seasonality

The Dilemma of Influenza Vaccine Recommendations when Applied to the Tropics: The Brazilian Case Examined Under Alternative Scenarios

Wyller Alencar de Mello¹, Terezinha Maria de Paiva², Maria Akiko Ishida², Margarete Aparecida Benega², Mirleide Cordeiro dos Santos¹, Cécile Viboud³, Mark A. Miller³, Wladimir J. Alonso³*

¹ Evandro Chagas Institute (IEC), WHO Global Influenza Surveillance Network (GISN), Secretary of Surveillance in Health, Brazilian Ministry of Health, Ananindeua, Para, Brazil, ² Adolfo Lutz Institute (IAL), WHO Global Influenza Surveillance Network (GISN), Secretary of Health of São Paulo State, Brazilian Ministry of Health, São Paulo, São Paulo, Brazil, ³ Fogarty International Center, National Institutes of Health, Bethesda, Maryland, United States of America

Abstract

Since 1999 the World Health Organization issues annually an additional influenza vaccine composition recommendation. This initiative aimed to extend to the Southern Hemisphere (SH) the benefits—previously enjoyed only by the Northern Hemisphere (NH)—of a vaccine recommendation issued as close as possible to the moment just before the onset of the influenza epidemic season. A short time between the issue of the recommendation and vaccine delivery is needed to maximize the chances of correct matching between putative circulating strains and one of the three strains present in the vaccine composition. Here we compare the effectiveness of the SH influenza vaccination adopted in Brazil with hypothetical alternative scenarios defined by different timings of vaccine delivery and/or composition. Scores were based on the temporal overlap between vaccine-induced protection and circulating strains. Viral data were obtained between 1999 and 2007 from constant surveillance and strain characterization in two Brazilian cities: Belém, located at the Equatorial region,
Southern Hemisphere Flu vaccine not good for Brazil?
influenza viruses isolated monthly from 1999 to 2007 in Belém and São Paulo
Southern and Northern Hemisphere recommendation
Matches with Southern Hemisphere recommendations

<table>
<thead>
<tr>
<th>A</th>
<th>(H1N1)</th>
<th>Beijing/262/95</th>
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<tbody>
<tr>
<td>Sydney/05/97</td>
<td>Panama/2007/99</td>
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<tr>
<td>(H3N2)</td>
<td>Fujian/411/2002</td>
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<tr>
<td>Wellington/1/2004</td>
<td>California/7/2004</td>
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<tr>
<td>Wisconsin/67/2005</td>
<td>Yamagata like</td>
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<tr>
<td>Beijing/184/93 (Yamanashi/166/98)</td>
<td>Sichuan/379/99</td>
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<tr>
<td>(H3N2)</td>
<td>Shanghai/361/2002</td>
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<tr>
<td>Victoria like</td>
<td>Hong Kong/330/2001 (Hong Kong/1434/2002)</td>
<td></td>
</tr>
<tr>
<td>Malaysia/2506/2004</td>
<td>11 matches</td>
<td></td>
</tr>
</tbody>
</table>

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26 March 2014 Dubai
Matches with Northern Hemisphere recommendations

A

(H1N1)

Beijing/262/95

New Caledonia/20/99 (isolates H1N2 in 2003)

Solomon Islands/3/2006

Sydney/05/97

Panama/2007/99

Fujian/411/2002

Wellington/1/2004

California/7/2004

Wisconsin/67/2005

(Yamagata like)

Beijing/184/93

Yamanashi/166/98

Sichuan/379/99

Shanghai/361/2002


(B) Victoria like

Malaysia/2506/2004

24 matches
Influenza in China


Complexity of influenza seasonal patterns in the inter-tropical zone impedes the establishment of effective routine immunization programs.

..... Here we characterize the diversity of influenza seasonality in China and make recommendations to guide future vaccination programs.

......regional vaccination may differ
Pandemic viruses will be more lethal and transmissible and less seasonal.
Summary

- Variable or no seasonality in tropical areas
  - Not as straight forward as temperate climates
  - Immunity and socioeconomic factors play a role

- Each country needs to collect data to determine the most appropriate strains for vaccines.
  - These may differ from the WHO recommendations
  - Countries embracing tropical and temperate geography may be better to choose the WHO NH recommendations or have different vaccines for different regions.
  - QIVs may solve issues for countries with circulating B viruses which are different to WHO recommendations.

- Future Pandemic viruses are likely to be more lethal and transmissible and NOT affected by seasonality