Epidemiological modelling, surveillance and web-based information systems: tools for public health decision making

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Background

- Public health threats
  - Emerging infectious diseases (SARS, pandemic influenza, chikungunya)

- Public health planning, preparedness, risk assessment, crisis management, decision making

- Tools for public health decision making
  - Expert opinion (infectious diseases specialists)
  - Infectious diseases surveillance systems
  - web-based information systems (Medisys; HEDIS)
  - Epidemiological modelling

Data sources

- Minimum amount of data needed
  - Reliable numbers of cases and deaths at the local, regional and national level
- Sentinels of general practitioners, nursing homes, hospitals etc.
- Information from national and international surveillance systems
- Fast and reliable reporting of the first few hundred cases is essential for estimates of the force of infection and predictions
- Problems: data sources often diverse; cases aren't clinically confirmed, sampling bias

Surveillance

- Public health surveillance systems provide information about:
  - Incidence
  - Case-fatality rates
  - Age structure of the population
  - Susceptible population groups
  - Geographical distribution of incidence
  - Etc.
- Information is usually reliable and precise
- In case of a pandemic: additional fast information is needed
  - Case identification, date of symptom onset, number of cases with clinical symptoms, number of hospitalisations, number of deaths etc.

Web-based information systems

- Public health crisis: Infectious diseases are characterised by high transmission probability in time and space
- Information from other sources than surveillance are useful
- Web-based information systems, such as the EC-JRC HEDIS, retrieve information fast from a wide variety of web sources with real time updates (e.g. MediSys, PROMED, WHO)
- HEDIS allows public health institutions of EU-member states to exchange health related information in a structured manner. The web site contains:
  - Situation awareness tools, interactive maps, alerting systems
- However, information has a signal sparking character only: useful for trend identification, early notification, situation reporting.
  - Reliability of information limited

Use of search engine query data (e.g. Google, Yahoo)

- Hypothesis: People with more frequently search the Internet using flu-related terms when they get sick. Search of Google's / Yahoo's query logs
- Yahoo study: Keywords collected "flu", "influenza". Comparison of the relative frequency of the search terms 2004-2008 with weekly national data on surveillance indicators of flu (positive viral isolates, flu mortality rates).
- Claim: Could see weekly variation in seasonal influenza up to 5 weeks in advance of mortality reports.
- Google study: Combinations of terms to find best fits against weekly CDC data (2003-2007).
- Claim: The predictive models based on best-fits terms were 1-2 weeks ahead of the CDC reports.
- Patterns of searches matched well with official influenza surveillance data

- ATTENTION: Prone to false alarm. Don't provide key information found through recording cases and viral isolates.

- Approaches might have some kind of supplementary function

- Privacy and confidentiality issues since information on individual searches is possible.


Home Page - Microsoft Internet Explorer
http://hedis.jrc.it/HomePage/tabid/36/Default.aspx
Public Health
Europa > European Commission > Public Health
HEDIS
Health Emergency & Diseases Information System
Wednesday, March 29, 2006
Alessandro Annunziato Logout
Home Page
Situation Update
On-going Activity
News
Reports
Documents
Questionnaires
Communication
Web Tools
Coordinates C3
Other Threats
thueringer-allgemeine - EU schafft rechtliche Basis für Hilfen in der Vog
2006/04/02 02:00:00
Legend
Wild bird
Domestic bird
Domestic Mammal
Human Infected
Human Fatal
Click the above image and press (Z) to zoom, (A) to un-zoom; pass the mouse on a symbol or click it to get information
Access the Google Earth file of the location of the cases
Download Google Earth
Links
Seasonal Influenza Weekly Bulletin
JRC - Avian Flu Web Site
ECDC Update page
WHO Euro Update
WHO Headquarter
DG Sanco Page
Digital Maps
Medisys
EWRS
RAS BICHAT
Last Documents
EFSA scientific report on avian influenza and food safety
24/03/2006
Scientific report of the Scientific Panel on Biological Hazards on "Food as a possible source of infection with highly pathogenic avian influenza viruses for humans and other mammals"
Go to folder
WHO advice on use of Oseltamivir
20/03/2006
WHO advice on use of Oseltamivir for treatment and prevention of influenza
Go to folder
H5 found in a farm in Sweden
17/03/2006
Avian influenza H5N1
HEDIS White Board
Current Topics
Avian Flu:
Overall situation: Overall Map
Austria
Albania
Azerbaidjan
Bulgaria
Cameroun
Croatia
Denmark
Egypt
Ethiopia
France
Germany
Greece
Georgia
Hungary
Poland
Italy
India
Kazakhstan New
Myanmar
Slovenia
Slovakia
Sweden
Switzerland
Romania
Turkey
Nigeria
Iran
Iraq
Pakistan
Medisys news
Breaking News Level :
strange (High)
Foreign Ministry warns of serious threat to Russia from bird flu New
01 hours 26 min ago
Avian influenza Situation in China â€" update 8 New
04 hours 53 min ago
Avian influenza Situation in China â€" update 8 New
05 hours 03 min ago
29-MAR-2006 / Avian influenza, human - worldwide (36): Cambodia, Egypt New
06 hours 09 min ago
PRO/AH/EDR> Avian influenza, human - worldwide (36): Cambodia, Egypt New
06 hours 09 min ago
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00 hours 16 min ago
INTERVIEW-India's bird flu fight hit by bad samples-lab head (AlertNet) New
00 hours 17 min ago
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00 hours 20 min ago
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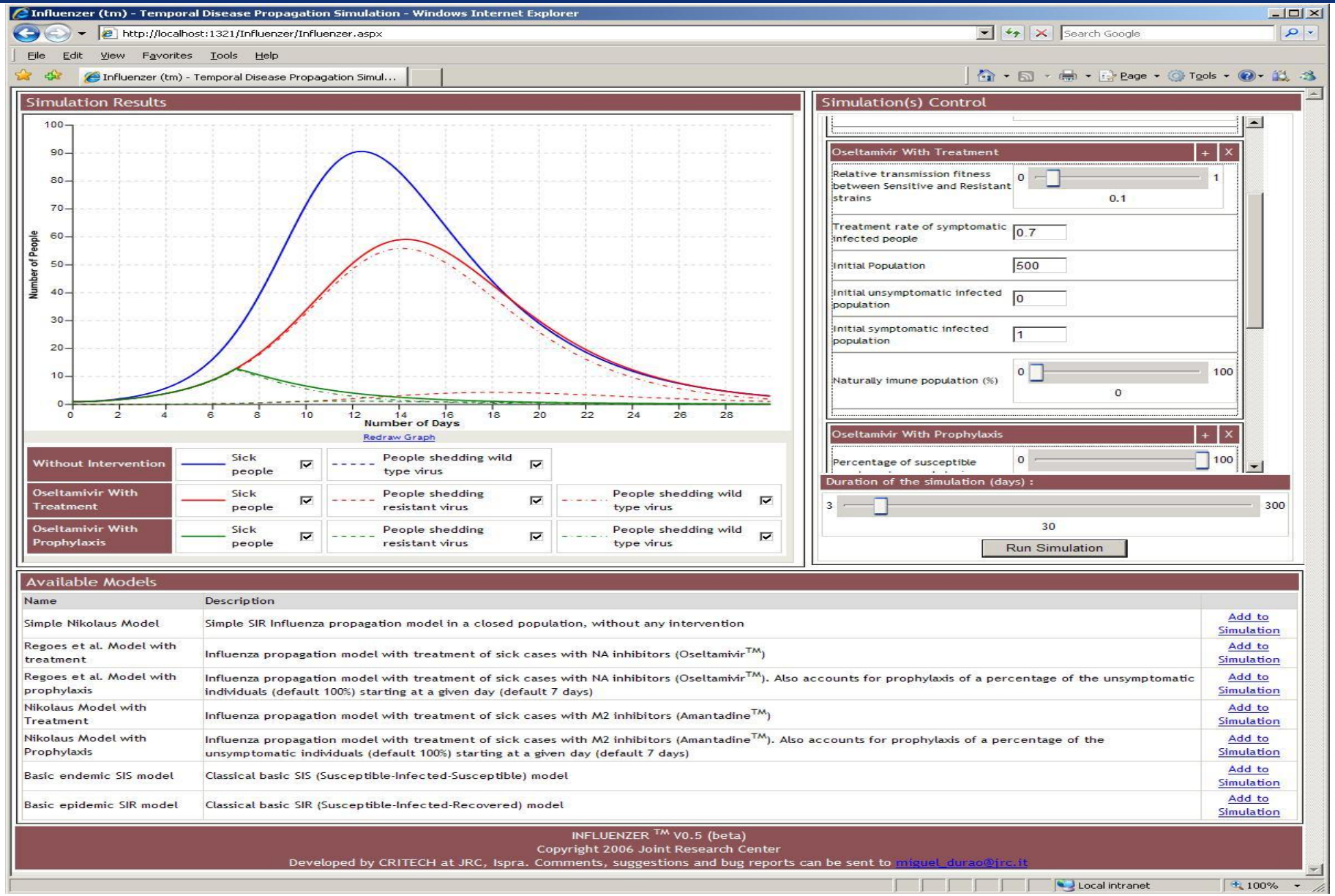
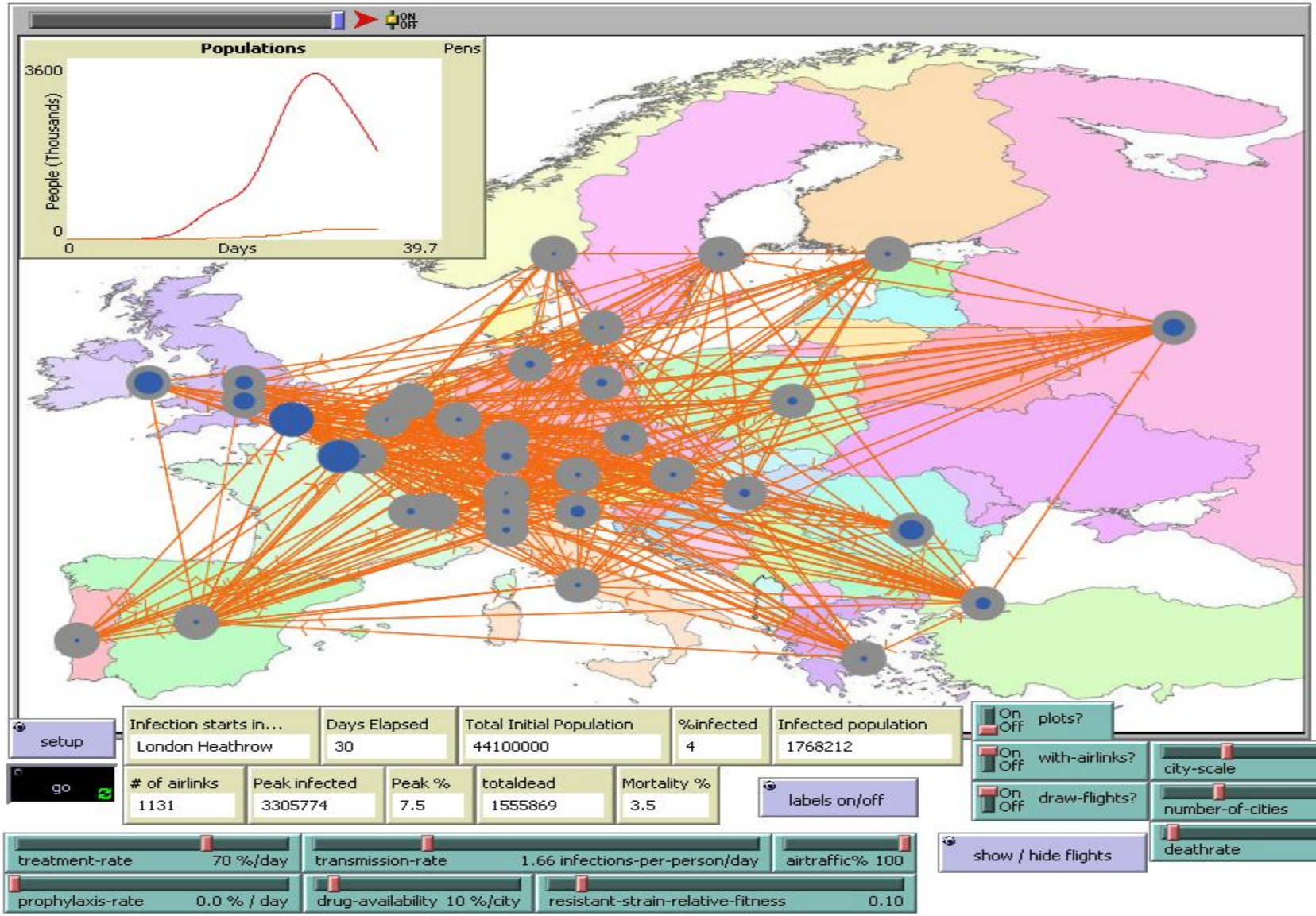
Log activity
European Medicines Agency meets with avian flu manufacturers
Internet

Epidemiological modelling

- Modelling as a tool
  - Based on certain assumptions about how people interact and how infectious diseases are transmitted
  - Information about the infectious agent under consideration and the community at risk is integrated
  - Predictions are made
  - Intervention scenarios are explored

- Public health decision makers and researchers analyse and compare the results to better understand how an outbreak occurs and spreads and what would be the impact of interventions


Influenzer (tm) - Temporal Disease Propagation Simulation - Windows Internet Explorer
http://localhost:1321/Influenzer/Influenzer.aspx
Search Google
File Edit View Favorites Tools Help
Influenzer (tm) - Temporal Disease Propagation Simul...
Page Tools
Simulation Results
Number of People
Number of Days
Redraw Graph
Without Intervention
Sick people
People shedding wild type virus
Oseltamivir With Treatment
Sick people
People shedding resistant virus
People shedding wild type virus
Oseltamivir With Prophylaxis
Sick people
People shedding resistant virus
People shedding wild type virus
Simulation(s) Control
Oseltamivir With Treatment
Relative transmission fitness between Sensitive and Resistant strains
0.1
Treatment rate of symptomatic infected people
0.7
Initial Population
500
Initial unsymptomatic infected population
0
Initial symptomatic infected population
1
Naturally imune population (%)
0
Oseltamivir With Prophylaxis
Percentage of susceptible
Duration of the simulation (days) :
30
Run Simulation
Available Models
Name
Description
Simple Nikolaus Model
Simple SIR Influenza propagation model in a closed population, without any intervention
Add to Simulation
Regoes et al. Model with treatment
Influenza propagation model with treatment of sick cases with NA inhibitors (Oseltamivir™)
Add to Simulation
Regoes et al. Model with prophylaxis
Influenza propagation model with treatment of sick cases with NA inhibitors (Oseltamivir™). Also accounts for prophylaxis of a percentage of the unsymptomatic individuals (default 100%) starting at a given day (default 7 days)
Add to Simulation
Nikolaus Model with Treatment
Influenza propagation model with treatment of sick cases with M2 inhibitors (Amantadine™)
Add to Simulation
Nikolaus Model with Prophylaxis
Influenza propagation model with treatment of sick cases with M2 inhibitors (Amantadine™). Also accounts for prophylaxis of a percentage of the unsymptomatic individuals (default 100%) starting at a given day (default 7 days)
Add to Simulation
Basic endemic SIS model
Classical basic SIS (Susceptible-Infected-Susceptible) model
Add to Simulation
Basic epidemic SIR model
Classical basic SIR (Susceptible-Infected-Recovered) model
Add to Simulation
INFLUENZER ™ V0.5 (beta)
Copyright 2006 Joint Research Center
Developed by CRITECH at JRC, Ispra. Comments, suggestions and bug reports can be sent to miguel_durao@jrc.it
Local intranet
100%


Populations
Pens
3600
People (Thousands)
0
0
Days
39.7
setup
go
Infection starts in...
London Heathrow
Days Elapsed
30
Total Initial Population
44100000
%infected
4
Infected population
1768212
# of airlinks
1131
Peak infected
3305774
Peak %
7.5
totaldead
1555869
Mortality %
3.5
labels on/off
plots?
with-airlinks?
draw-flights?
show / hide flights
city-scale
0.8
number-of-cities
88
deathrate
5 %/day
treatment-rate
70 %/day
transmission-rate
1.66 infections-per-person/day
airtraffic%
100
prophylaxis-rate
0.0 % / day
drug-availability
10 %/city
resistant-strain-relative-fitness
0.10

Why real time models?

- To provide estimates of what is happening during an epidemic and particularly a pandemic, e.g. numbers of infected people
- To monitor hospital capacity and to check health care system resilience
- To assess logistical demands (e.g. antiviral stockpile and delivery)
- To monitor how well suggested control methods work
- To allow adaptation of control measures during an epidemic

To predict future incidence

Real time parameter estimation tools

- User friendly
- Easy to adjust (e.g. re-parameterisation)
- Computationally efficient
- Easy to understand and use output
- Effective at estimating future incidence

- Problems
  - Fast access to reliable data
  - Quality of reporting systems
  - Data delays
  - Multiple non-standardised sources
  - Infrastructure for reporting systems, modelling and coordination of public health decision makers

Reflexions on modelling as a tool in public health decision making

- Modelling in public health should be seen as a complementary tool to the so called expert opinion
- Modelling has contributed little to policy development in Europe and this needs to change
- Modelling provides insights, not answers
- Model only as effective as surveillance systems allow
- Models are question specific. ‘The’ model doesn’t really exist
- Isolated modelling results will never drive policy making
- Interfacing with policy makers absolutely necessary (expectations)
- Research support for evidence based public health policy (MIDAS initiative USA)

Conclusions

- Modelling in conjunction with surveillance and web-based medical systems are important tools for public health decision making during epidemics and pandemics

- Establishment of the necessary infrastructure is a major challenge to the national and European health systems

Thank you