Pandemic influenza in Sweden - comparing different intervention strategies

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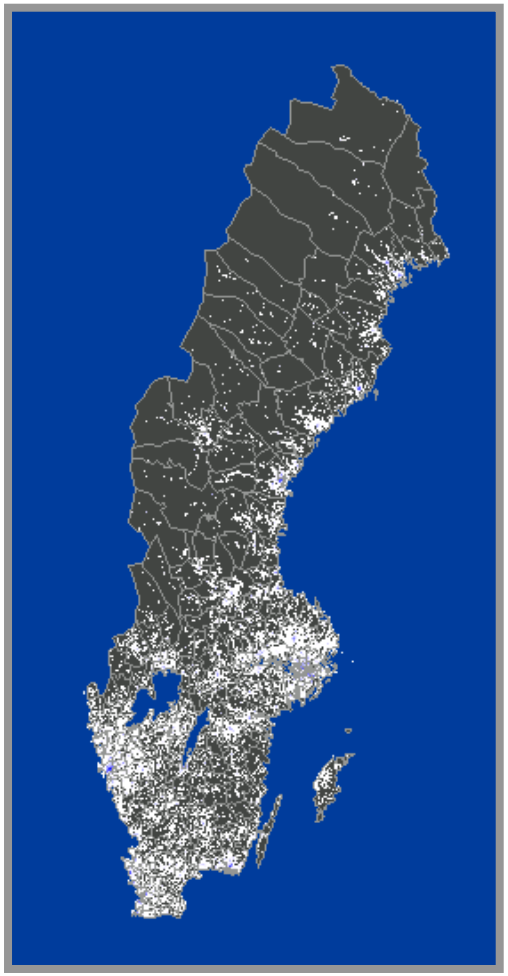
Outline



- Motivation
- Data
- Model
- Outbreak without interventions
- Experiments w vaccination
- Results
- Visualizing outbreaks

Motivation

- Decision support to policy makers
- Preparedness plans for Pandemic Influenza - compare different intervention strategies
- Scenario-based, if – then rather than predictions
- I work together with Martin Camitz, Baki Cakici, Paul Saretok and Kalle Mäkilä
- Financed by the Swedish Emergency Management Agency (KBM)

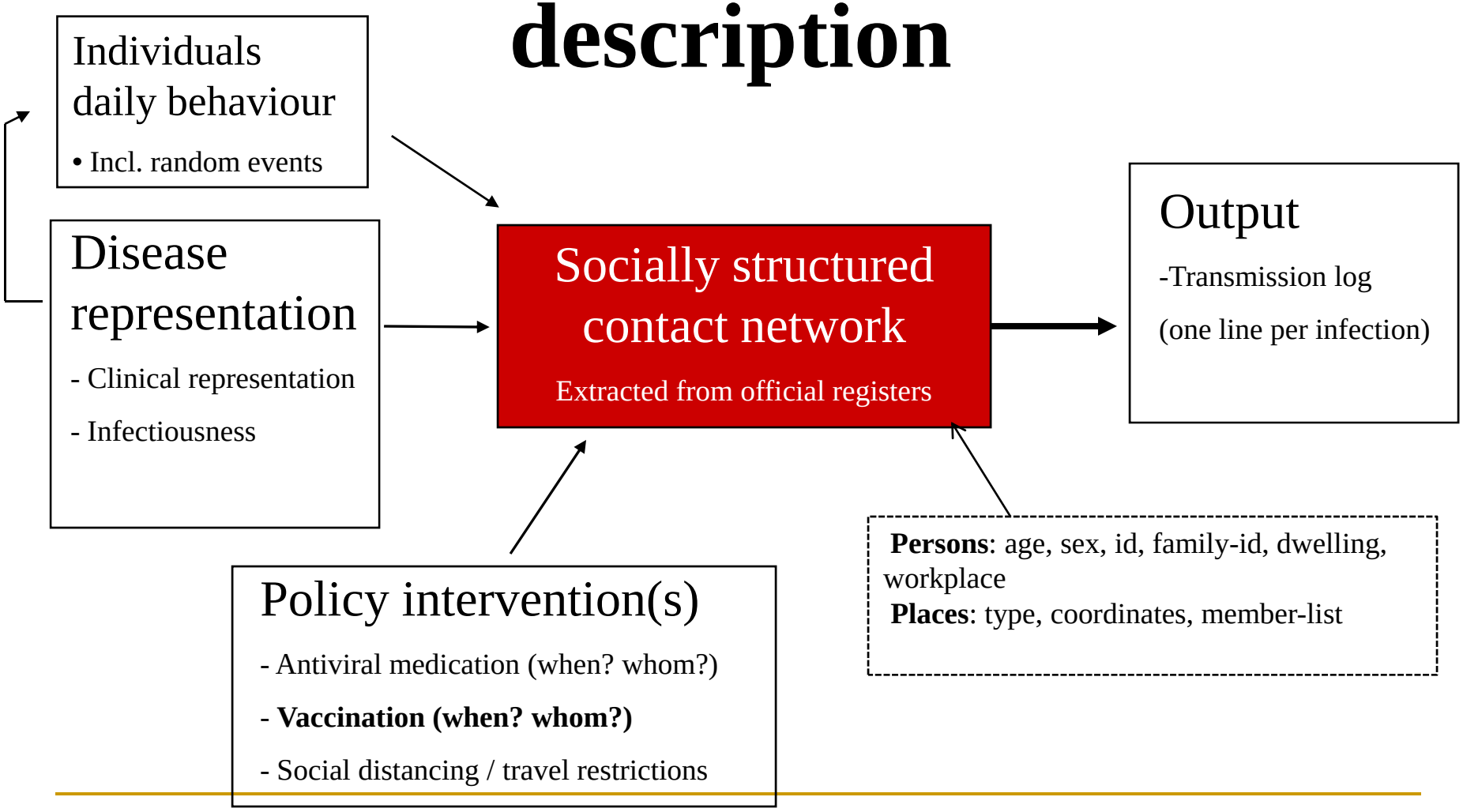
The MicroSim model is individual-based

- The contact structure in a population is important for the spread of an infectious disease
- Transmission is most likely when persons are at the same place at the same time
- The contact structure can be represented in the form of a mixing network:
  - nodes: persons
  - edges: contacts between persons
- Targeted interventions can be tested

What data are used?

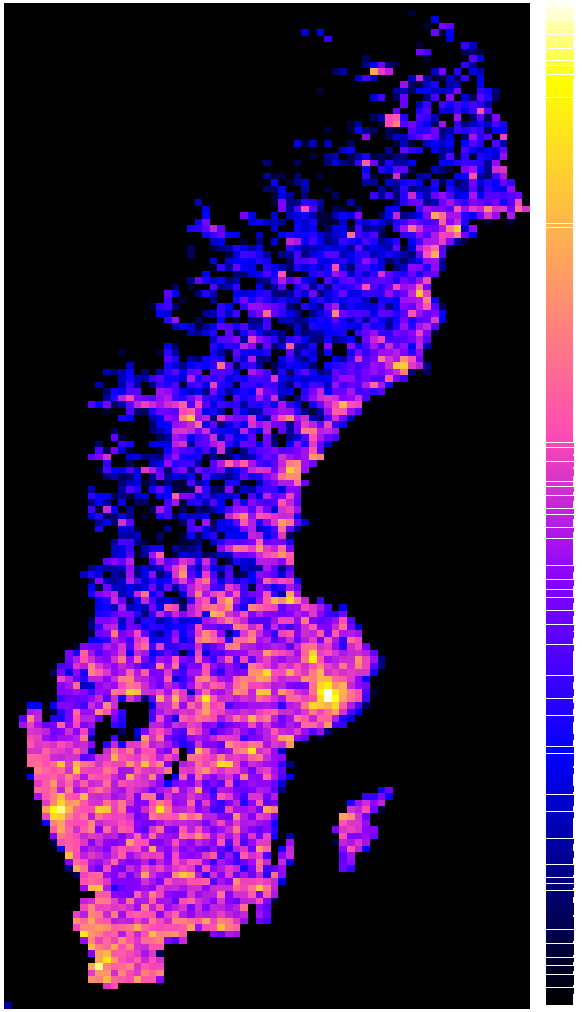
- Total population model (~ 9 million persons)
- Three administrative registers were used; the Swedish Total Population Register (1999), the Swedish Employment Register (1999) and the Geographic Database of Sweden (2000).
- The registers were linked by the unique personal identification number by SCB
- Before delivery the id-number was removed

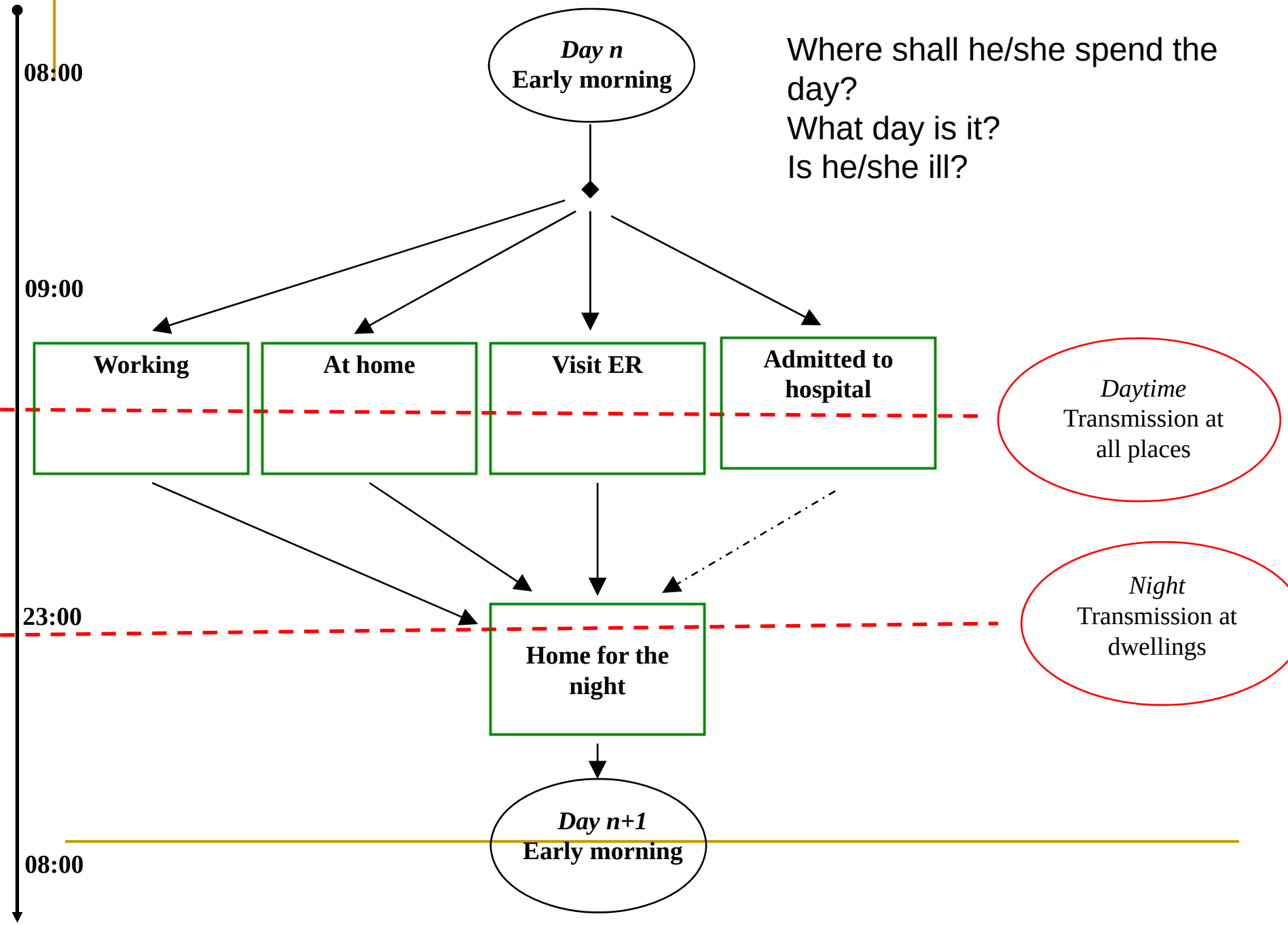
Simulation model – conceptual description



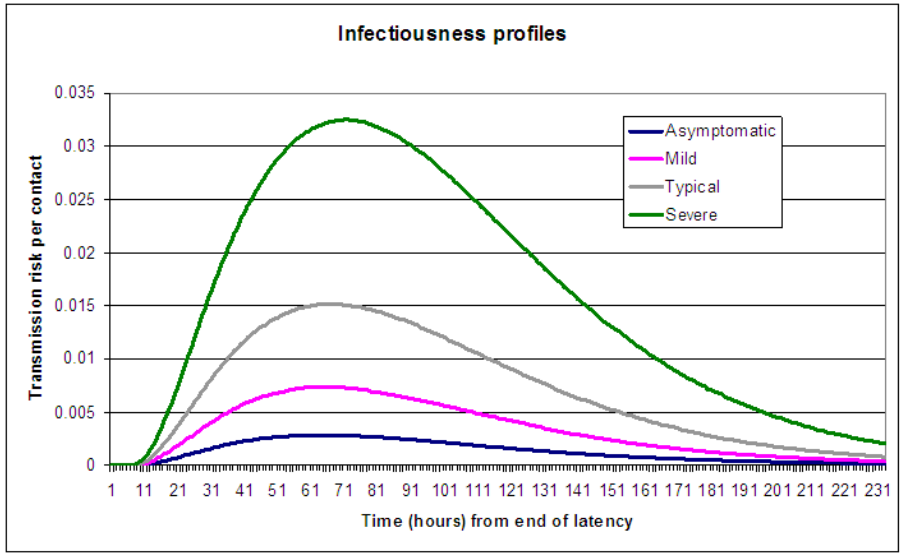
Connecting persons to space

- Most people are connected to two places; their dwelling and their workplace/school/day care center.
- The coordinates of all places point at the lower left corner of a 100 x 100 meter cell.



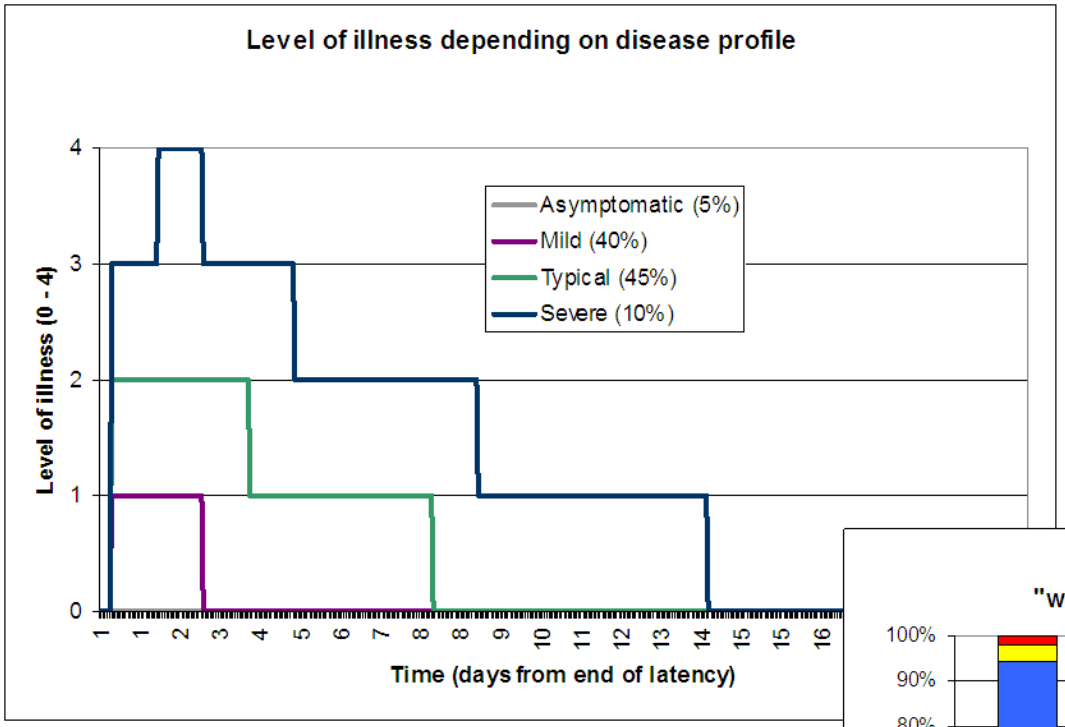

08:00
Day n
Early morning
Where shall he/she spend the day?
What day is it?
Is he/she ill?
09:00
Working
At home
Visit ER
Admitted to hospital
Daytime
Transmission at all places
23:00
Home for the night
Night
Transmission at dwellings
Day n+1
Early morning
08:00

Disease representation pandemic influenza - infectiousness

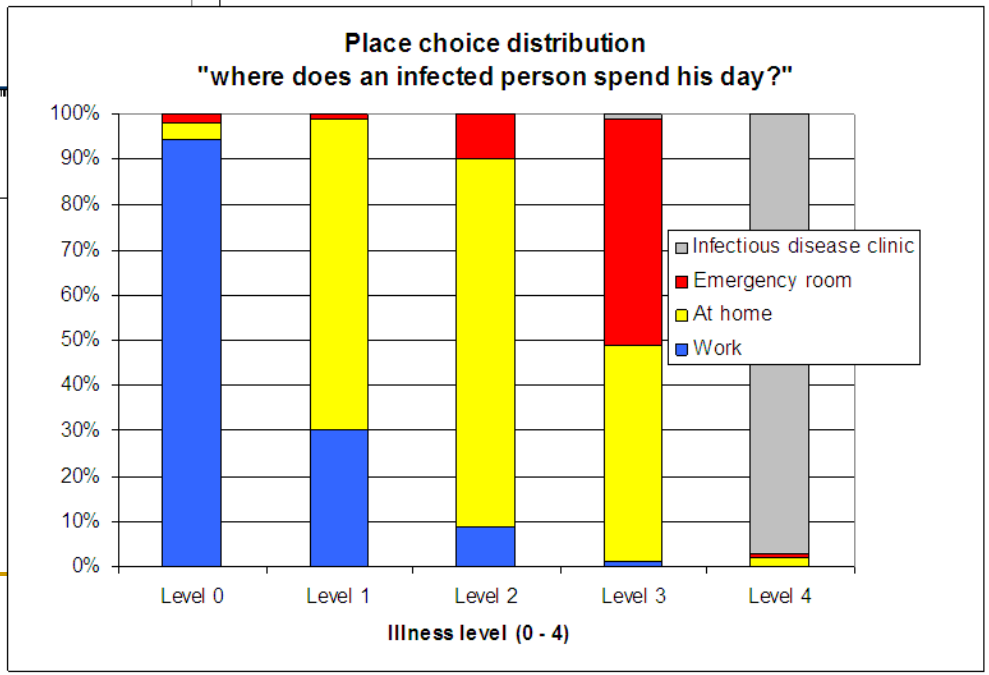


- 4 severity levels:
  - Asymptomatic
  - Mild
  - Typical
  - Severe (most infectious)

Where does an infected person spend the day?



Place choice depends on disease level, which depends on disease profile + time from infection



How is the disease spread

The transmission process runs at all places with more than one member, where at least one person is infectious and one is susceptible, by looping through the member lists.

The risk of getting infected depends on:

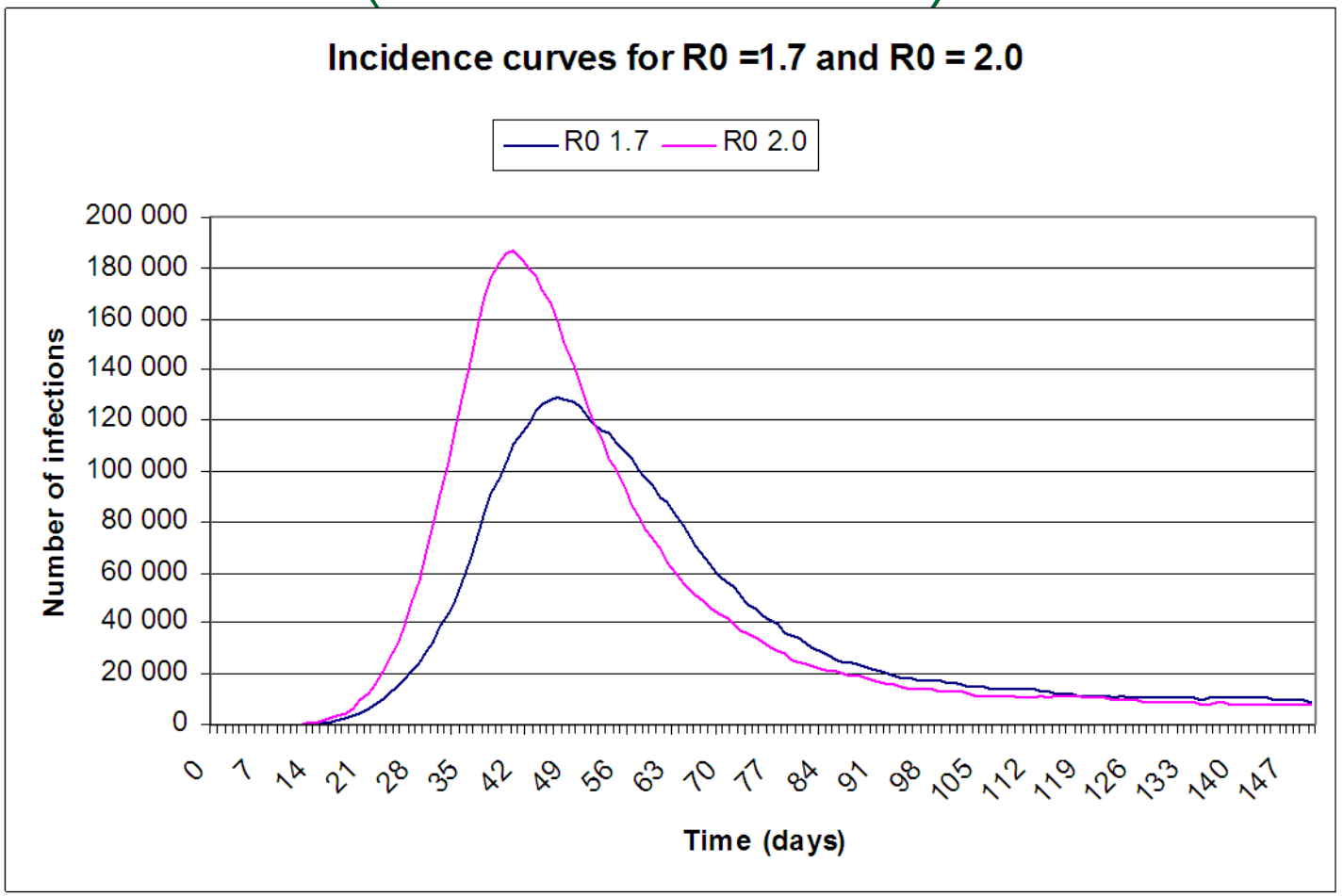
1. The number of infectious persons at the place
2. How infectious they are

Description of experiments

- Severity of pandemic – mild or severe?
  - R0 2.0 -> severe
  - R0 1.7 -> a bit milder
- Introduction of disease in population: 50 randomly picked persons are infected day 0
- Baseline (no interventions)
  - 10 x 150 days with severe, 10 x 150 days with mild
- For each vaccination scenario:
  - Early start (day 2)
    - 10 x 150 days with severe, 10 x 150 days with mild
  - Later start (day 49)
    - 10 x 150 days with severe, 10 x 150 days with mild

- **One realization (150 days) takes approx. one hour to run.**
- **10 realizations are enough for stable results**

Baseline for experiments: Outbreak without interventions (no vaccination)



R0 1.7 -> 5.5 million R0 2.0 -> 6.2 million

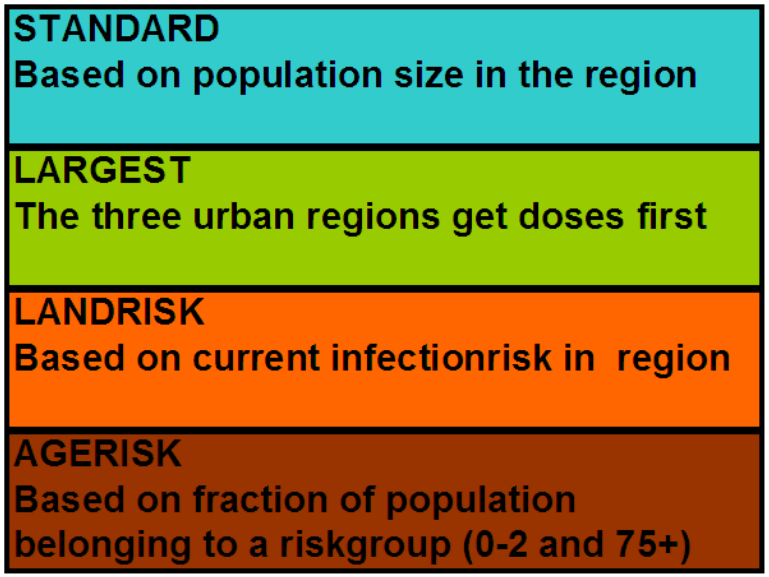
4 strategies on how to best distribute the doses between the 21 counties

Standard: Distribute vaccine to counties proportional to their population, new doses are delivered until 90 % of the population is vaccinated twice.

Largest: Doses are distributed to the three metropolitan counties first, until 75% of their population has been vaccinated at least once – then Standard is used.

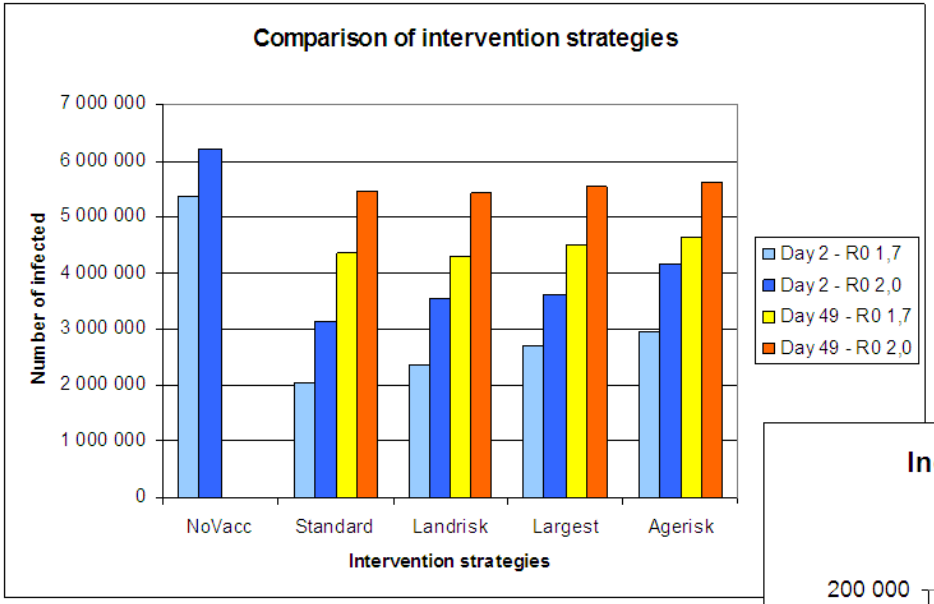
Landrisk: Distribute vaccine to counties proportional to the number of currently infected individuals there.

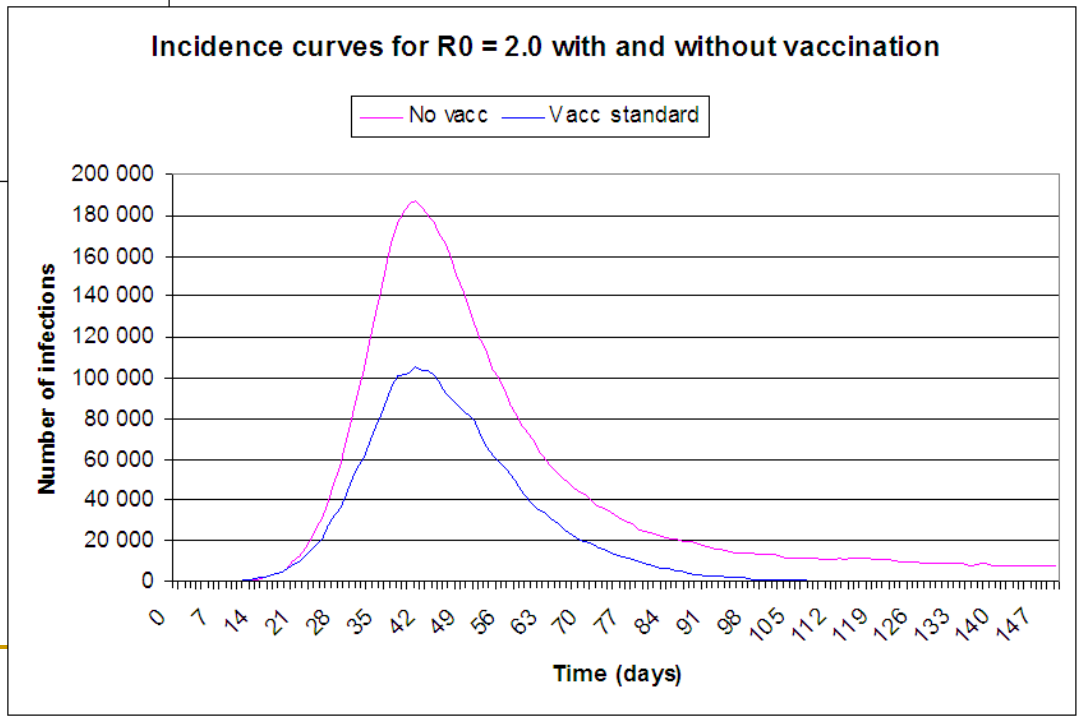
Agerisk: Number of doses depends on the size of the risk categories in the county population (0-2 and 75+).



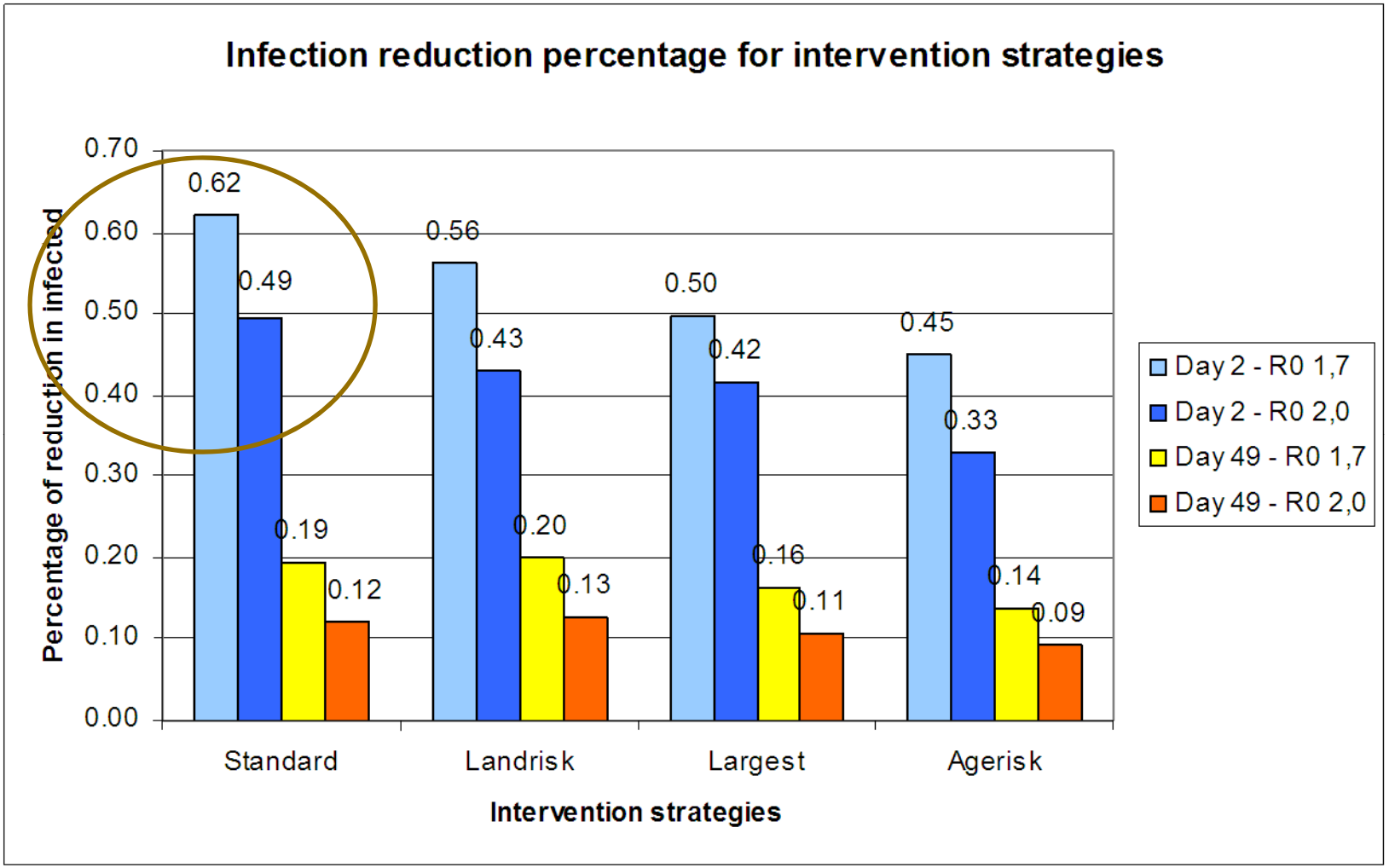
Doses II are not delivered to the counties until 3 weeks have passed and 90 % of the population is vaccinated once.
No person receives more than two doses.
In strategies 1 – 3 persons are randomly picked for vaccination. In the Agerisk strategy the risk groups are first vaccinated.

How good were the interventions?





Overview (cont'd)



Summary

- Quick start of vaccination is most important
- Standard distribution is best for reducing number of cases and deaths, but the differences were small

Average reduction (all intervention strategies)

START DAY 2

- R0 1.7 53 %
- R0 2.0 42 %

An immediate start may half the number of infections.

START DAY 49

- R0 1.7 17 %
- R0 2.0 11 %

Starting after 7 weeks gives 10 – 20 % reductions .

Visualizing the outbreak : Google Earth

- Google Earth uses an XML-based language KML (Keyhole Markup Language) to store and display data associated with maps. This file is composed of placemark objects where the only required field is the coordinate itself. In addition, every placemark can display additional info when clicked, use a custom icon, and be visisble only during a certain time interval.

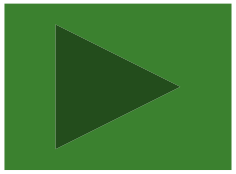
- Our software (flumaps) reads the simulation output log and converts every line into a placemark object in a KML file. The placemark object contains date, age, sex, place type and coordinates of where the infection took place. The coordinate conversion is as follows:
  - Extract the RT90 coordinates from the output log
  - Convert to the international standard WGS84 coordinates (uses SWEREF99 as an intermediate step)

- When the resulting KML file is opened with Google Earth, the placemarks are displayed in order according to their date timestamps automatically (thanks to Google Earth).

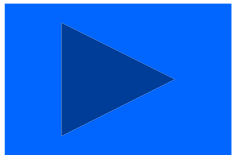
Google Earth

- Comparing outbreaks
  - Left: no intervention
  - Right: vaccination (standard, start day 2)
- Colour indicates the age of the infected person:

0 - 4 blue / 5 - 14 green / 15 - 44 yellow / 45 - 64 orange / 65+ red



Sweden



Stockholm

- Thank you for your attention!
- Questions?