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# Model Interventions for Epidemics

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## ABSTRACT

The new proposed ABM reproduces quite well both the epidemic dynamics for whole city and epidemic dynamics in age groups Therefore, we now can use it for analyzing an effectiveness of any interventions both those that have been done during the epidemic under consideration and those that may be done evaluating simultaneously cost of all these interventions if corresponding prices are available of course, preliminary analysis of ongoing epidemics or, more important, ongoing pandemics would be a much more interesting possibility For the first time the new proposed ABM gives such an opportunity under two main conditions.

## KEYWORDS

*Administrative decision; Agents-based model; Influenza epidemic/pandemic; Interventions.*

### 1. Introduction

Agents-based models (ABMs) become more and more popular in applied mathematics During last 15 years, a large number of ABMs have been created and used in epidemiology These ABMs have been created on the base of an agent's contact network that in its turn is created from demographic and infrastructural information about city or area under consideration Unknown, probabilities to get infected during contacts of infectious and health residents have to be defined from information provided by surveillance centers for different age groups The first ABMs for dynamics of infectious diseases appeared at the very beginning of this century [1-4] Unfortunately, both these pioneer papers and many subsequent papers contain several false suppositions and mistakes that led only to qualitative results for dynamic of epidemic/pandemic under consideration A level of uncertainty of such results does not allow recommending any quantitative interventions that could contribute to decreasing number of infected residents during the epidemic/pandemic In this paper, a critical review of currently accepted ABMs of such special type has been carried out and new ABM has been proposed.

Let us for analysis's simplicity consider a creation of ABM for influenza dynamic in a city Probabilities for susceptible people from different age groups to get infected during a contact with infectious people have to be evaluated from the patterns ie cumulated attack rates (numbers of infected people from the beginning of epidemic/pandemic) as functions of time for different age groups This standard data are provided by city's epidemic surveillance center.

• In the pioneer ABMs (and in many subsequent models) probabilities of being infected in the different types of working places (daycares, kindergartens, schools, institutes and other working places) and households during a contact with infectious person are used as model's parameters.

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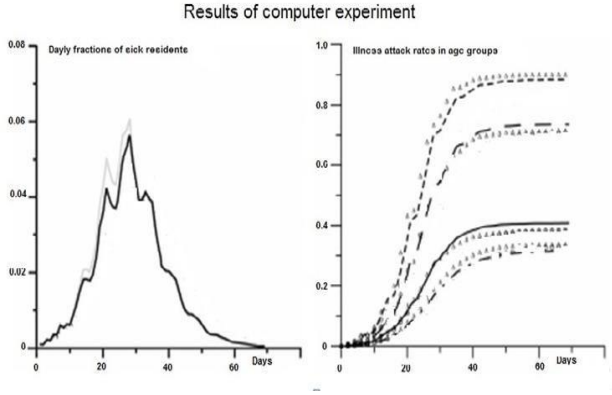


**Figure 1.** Checking the working capacity of the new ABM.

New ABM has been checked with the help of following procedures in (figure 1).

- For contact network of Dresden (Germany) and arbitrary values of probabilities to get infected in 4 age groups daily fractions of sick residents (black line on the left picture) and illness attack rates in all groups (lines of different types at the right picture) have been calculated ("exact solution");
- For these exact illness attack rates and other initial set of probabilities values to get infected the regularization problem of Tikhonov was solved New values of probabilities to get infected in 4 age groups were calculated For these new probabilities, daily fractions of sick residents and illness attack rates are compared with "exact" ones by a grey line and triangles correspondingly.

## 2. Discussion

The new proposed ABM reproduces quite well both the epidemic dynamics for whole city and epidemic dynamics in age groups Therefore, we now can use it for analyzing an effectiveness of any interventions both those that have been done during the epidemic under consideration and those that may be done evaluating simultaneously cost of all these interventions if corresponding prices are available of course, preliminary analysis of ongoing epidemics or, more important, ongoing pandemics would be a much more interesting possibility For the first time the new proposed ABM gives such an opportunity under two main conditions.

- One has all history parameters and outbreak dynamics for completed pandemic under consideration in some another city (source-city).
- There is a time-gap between outbreaks in two cities.

Agent-Based Models for Influenza Epidemic Dynamics and Its Decision-Making Capability

Often surveillance centers in different countries (even sometimes in the same one!) use for watching a different number of age groups In such a case we have to create the same age groups in the city under consideration Note that it would be more radical and more helpful to save age for any case of infection in a surveillance centre Such a format of keeping information would allow creating any number of age groups and this fact can be used for their optimization If so, one can construct contact network for the source-city and with the help of new proposed ABM to evaluate probability values to get infected during a contact between susceptible and infectious persons for different age groups Knowing these probabilities one can simulate future outbreak dynamics in the city under consideration Many possible interventions can be checked before outbreak and the best of them can be proposed for subsequent realization before and during the future outbreak.

## 3. Concluding Remarks

As result of critical review of currently accepted agentsbased models (ABMs) for influenza spreading in cities new ABM has been proposed It can be used not only for analyzing results of past epidemic but for analyzing (under some conditions) ongoing epidemic/pandemic and optimization effectiveness of different possible intervention These possibilities of new ABM have been demonstrated at a test case of epidemic in a city For practical application of new ABM the results obtained must be confirmed at the real epidemic and pandemic.

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