Application of geospatial multi-agent system for simulation of different aspects of tuberculosis transmission

Part one

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Conflict of interest: none

BACKGROUND. The article presents the modeling of the epidemiological picture of tuberculosis (TB) using a multi-agent system. This is to provide an in-depth multi-agent modeling study with comprehensive strategies related to TB treatment and prevention.
OBJECTIVE. To develop an algorithm that uses the capabilities of artificial intelligence and neural networks to build a geospatial model of TB transmission.
MATERIALS AND METHODS. This study involves the development of an algorithm that uses the potential of artificial intelligence to create a geospatial model that highlights the different routes of TB transmission. The simulation process itself is characterized by a number of key stages, including initialization of the city, calibration of health parameters, simulation of the working day, spread of infection, evolution of disease trajectories, rigorous statistical calculations and transition to the next day. A comprehensive description of the course of active TB according to official data of the World Health Organization is given. Each agent is provided with an appropriate and consistent model that includes relevant health attributes and necessary rules for their dynamic evolution.
RESULTS AND DISCUSSION. The process of modeling the transmission of TB in the urban landscape has been thoroughly investigated. Attributes and functional dependencies are divided into three different groups: static (or deterministic), stochastic, and empirical. Empirical parameters that determine the contagiousness of TB patients are subjected to careful analysis, during which the dynamic nature of their actual contagiousness is carefully compared. Therefore, the empirical parameters that determine infectivity are carefully established, which additionally allows for the quantitative determination of the level of TB infection. A complex simulation is presented that illustrates the spread of TB in a completely healthy environment devoid of any preventive or therapeutic measures. This simulation serves as a crucial study of the spread of the disease. To test the adequacy of the model and its sensitivity to the main parameters that determine the course of TB, a series of experiments using three different approximations, namely: a basic model, a model that includes mortality factors and a comprehensive model covering all relevant aspects, was conducted. Statistics used in this context include the number of infected and latent persons, recoveries and deaths. The article presents a comparative analysis between statistical information and a model that offers a comprehensive picture of the state of health of each person. The model allows careful monitoring of various factors, such as interpersonal contacts, place of residence, workplace, modes of transport used to move from place to place, and other vital aspects of a person's life, together contributing to a more complete understanding of the dynamics of the disease.
CONCLUSIONS. The calculations show the stability of the results and the absence of large fluctuations. The obtained statistical values of infected, latent and recovered people correlate with known medical data, and therefore, confirm the adequacy of the proposed model. This model allows tracking and analyzing the life and behavior of each agent, which allows for a detailed assessment and analysis of the spread of TB, as well as to develop a strategy to prevent the spread of this infection.

KEY WORDS: epidemiology, tuberculosis, modeling, agent, prevention, GeoCity.