DEVELOPMENT OF CHAIN MODELS OF THE DYNAMICS OF THE COVID-19 PANDEMIC SPREAD

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Abstract: The work confirms the correctness of the mathematical model of the spread of the coronavirus pandemic as a branched chain (autocatalytic) reaction. The results of the interpretation of statistical data within the framework of this model for the already completed — the first and second — and the ongoing (in May–June 2021) third waves of coronavirus for the city (Moscow), region (Yakutia), and country (Russia) are presented. The quantitative parameters of the logistic function were obtained which satisfactorily describe the spread of the pandemic in these three research objects. The model has predictive capabilities. It was shown that the constancy of the infection rate after a decrease in this value means the beginning of the next wave of coronavirus. The start date and the number of people infected in it can also be determined in advance. So, for the third wave of coronavirus which takes place in June 2021, using the model, the number of people who will be infected in the third wave of coronavirus and the time of its beginning were determined. Some of the patterns found are universal. In particular, the effective rate constant decreases with the transition from the first wave to the second. This can be explained by the growth of the so-called herd immunity. The model calculates a dynamic constant associated with the probability of infection for one person. This constant can change by more than two orders of magnitude when moving from one region to another.

Keywords: chain branching reaction; mathematic model; increase in the number of infected people; spread; predictions

Figure Captions

Figure 1 Transformation of the dynamics of the spread of the second wave of coronavirus in Moscow in coordinates $\ln(N_t/(800000 - N_t))$–time from 09.10.2020 to 10.01.2021: *1* — $\ln(N_t/(800000 - N_t))$; and *2* — linear dependence $y = 0.034x - 9.1854$, $R^2 = 0.9987$

Figure 2 Comparison of real (*1*) and calculated (*2*) number of infected people in Moscow in the second wave of coronavirus

Figure 3 Comparison of real (*1*) and calculated (*2*) infection rates in Moscow in the second wave of coronavirus

Figure 4 Difference between real and calculated data on the number of infected people in the second wave of coronavirus in Moscow

Figure 5 Conversion of the number of infected people in Moscow from 13.05.21 to 06.06.21 during the third wave of coronavirus in the coordinates of the logistic function: *1* — $\ln(N_t/(400000 - N_t))$; and *2* — linear dependence $y = 0.0299x - 13.772$, $R^2 = 0.9991$

Figure 6 Coronavirus infection rate in Moscow

Figure 7 Real (*1*) and estimated (*2*) number of people infected in the second wave of coronavirus in Russia

Table Captions

Table 1 Wave dynamics of coronavirus infection parameters in Moscow

Table 2 Wave dynamics of coronavirus infection parameters in Russia

Table 3 Wave dynamics of coronavirus infection parameters in Yakutia

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