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Mathematical modeling of COVID-19 transmission in the form of system of integro-differential equations

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The model of the spread of the coronavirus pandemic in the form of a system of integro-differential equations is studied. We focus our consideration on the number of hospitalized patients, i.e., on the needs of the system regarding hospital beds that can be provided for hospitalization and the corresponding medical personnel. Traditionally, in such models, the number of places needed was defined as a certain percentage of the number of infected at the moment. This is not quite adequate, since it takes a certain period of time for the development of the disease to the stage at which hospitalization is required. This will be especially evident at the start of new waves of the epidemic, when there is a large surge in the number of infected people, but the need for hospitalization places and additional medical personnel will appear later. Taking this circumstance into account using integral terms in the model allows us to conclude in corresponding additional to existing cases that the wave of disease will attenuate after some time. In others, it will relieve unnecessary panic, because the healthcare system has a certain period to create additional hospitalization places, order medicines and mobilize the necessary medical personnel. We obtain estimates of reproduction number in the case of the model described by a system of integro-differential equations. Results on the exponential stability of this integro-differential system are obtained. It is demonstrated that the condition of the exponential stability coincides with the fact that the reproduction number of the spread of the pandemic is less than one.