Epidemic model of age-structured population dynamics with incubation period of infection

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Advanced models for the spread of infectious diseases are based on the age-structured epidemic models. In this work we study an age-structured epidemic model of susceptible, infected and recovered (SIR) populations dynamics with delay parameter - incubation period of infection. The investigated model is given as a competitive Lotke-Volterra system of initial-boundary value problems for nonlinear hyperbolic (first order) partial differential equations with non-local integral boundary conditions and discrete time delay.

Using a method of characteristics we obtain the explicit recurrent formulae for the travelling wave solution of Lotka-Volterra system which guarantees existence and uniqueness of continuous solution and allows for developing of accurate numerical algorithm for simulation the epidemiology processes. Then, using some simplified assumptions we reduce the age-structured epidemic model with constant coefficients to the nonlinear autonomous system of delay ODE. The analysis of possible equilibria of such system provides the conditions of existence of trivial disease-free equilibrium, two non-trivial endemic equilibriums for the incurable and curable infection-induced diseases, respectively. The stability analysis of equilibria results in the restrictions on dimensionless stability indicators and infection period which guarantee existence of asymptotically stable behavior of solutions in the vicinities of steady states. The numerical simulations provide the practical insight into the different dynamical regimes of susceptible, infected and recovered subclasses and help us better understand the epidemiology of infectious diseases of biological populations in the real-world applications. The results of study were particularly presented in work [1].

References

[1] V.V. Akimenko, *An age-structured SIR epidemic model with the fixed incubation period of infection*, Comput. Math. Appl.**73** (2017)1485 – 1504.