Model for the transmission dynamics of a childhoold disease with temporary immune protection and reinfection in the presence of vaccination

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The basic question of how we acquire immunity has been invetsigated for a century or more. Even so, several concepts in immunology still remain unclear. For instance, it is known that the first exposure of an individual to an antigen elicits a primary response, the initial antigen response. When an individual is exposed to the same antigen for a second time, a much larger number of antibodies is produced quickly to combat the infection. When individuals are immunized, the vaccines induces their immune system to respond and produce antibodies against the "virus" in the vaccine. These antibodies then destroy the vaccine virus, but the immune system "remembers" the virus so that it can fight off infection if the individual is ever exposed to the natural virus (the ones that cause the disease). Because the virus in vaccine and the natural virus are very similar, the immune system responds to both. Vaccination is a method for inducing immunity in the population in order to control the spread of the disease. However, infection can happen even in individuals that acquired immunity by ways of the disease itself or by vaccination, this is re-infection. In this work we propose a mathematical model in which there is a distinction between first time infected individuals and re-infected ones. Our main assumption is that the transmission dynamics of a childhood disease in the presence of a preventive vaccine is such that immunity may wane in time, allowing recurrent infections. With this and other assumptions, the situation is modeled by a system of coupled non-linear differential equation. We use qualitative analysis of this system to find equilibrium points. This will allow us to understand why even with vaccination and re-vaccination some childhood diseases cannot be eradicated.

References

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