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MODELING DISEASE SPREAD VIA TRANSPORT-RELATED INFECTION BY A DELAY DIFFERENTIAL EQUATION

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ABSTRACT. A delayed SIS model is developed to describe the effect of transport-related infection, where time delay arises very naturally and the basic reproduction number R_0 can be calculated. It is shown that this number characterizes the disease transmission dynamics: if $R_0 < 1$, there exists only the disease-free equilibrium which is globally asymptotically stable; and if $R_0 > 1$, then there is a disease endemic equilibrium and the disease persists. Analysis of the dependence of R_0 on the transport-related infection parameters shows that an outbreak can arise purely due to this transport-related infection.

1. Introduction. Much has been done in terms of modeling spatial spread of diseases. For example, Wang and Ruan [**14**] studied the global spread pattern of the 2002–03 SARS outbreak. Rvachev and Longini [**6, 7**] used a discrete time difference equation in a continuous state space to study the global spread of influenza. Sattenspiel and Dietz [**8**] introduced a model with travel between populations, where they identified parameters in the case of the transmission of measles in the Caribbean island of Dominica and numerically studied the dynamics of the model. Sattenspiel and Herring [**9**] used the same type of model for the consideration of travel between populations in the Canadian subarctic, which can be thought of as a closed population where travelers can be easily quarantined. Extensions to include quarantine were given in [**10**] with an application to the data of the 1918–1919 influenza epidemic in the center of Canada. Metapopulation models involving multi-patches have also been recently studied in [**1, 13, 15, 16**].

Keywords and phrases. Transport-related infection, stability, delay, permanence.
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