Analysis of an epidemiological model structured by time-since-last-infection

Jorge A. Alfaro-Murillo a, Zhilan Feng b,∗, John W. Glasser c

a Center for Infectious Disease Modeling and Analysis, Yale School of Public Health, New Haven, CT, USA
b Department of Mathematics, Purdue University, West Lafayette, IN, USA
c National Center for Immunization and Respiratory Diseases, CDC, Atlanta, GA, USA

Received 24 April 2019; revised 3 June 2019; accepted 4 June 2019

Abstract

Modeling time-since-last-infection (TSLI) provides a means of formulating epidemiological models with fewer state variables (or epidemiological classes) and more flexible descriptions of infectivity after infection and susceptibility after recovery than usual. The model considered here has two time variables: chronological time (t) and the TSLI (τ), and it has only two classes: never infected (N) and infected at least once (i). Unlike most age-structured epidemiological models, in which the i equation is formulated using \( \frac{\partial}{\partial \tau} + \frac{\partial}{\partial t} \), ours uses a more general differential operator. This allows weaker conditions for the infectivity and susceptibility functions, and thus, is more generally applicable. We reformulate the model as an age dependent population problem for analysis, so that published results for these types of problems can be applied, including the existence and regularity of model solutions. We also show how other coupled models having two types of time variables can be stated as age dependent population problems.

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Keywords: Epidemiological model; Age-since-last-infection; Existence and uniqueness of solutions; Stability

∗ Corresponding author.
E-mail address: zfeng@math.purdue.edu (Z. Feng).

https://doi.org/10.1016/j.jde.2019.06.002
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Please cite this article in press as: J.A. Alfaro-Murillo et al., Analysis of an epidemiological model structured by time-since-last-infection, J. Differential Equations (2019), https://doi.org/10.1016/j.jde.2019.06.002