CONNELL MCCLUSKEY, Wilfrid Laurier University
Global Stability of Epidemic Models with Uniform Susceptibility

We consider a very general framework for compartmental disease models, allowing a single susceptible class and an arbitrary number of post-infection classes (including, for example, asymptomatic, mildly infectious, highly infectious, treated and quarantined groups).

Key model assumptions: (1) only one susceptible class, (2) no return from the infected classes to the susceptible class, (3) each infected class can (eventually) be reached from the susceptible class, (4) a "reasonable" incidence function.

We are able to fully resolve the global dynamics for the resulting ODE systems, obtaining the common threshold behaviour: If R0<1, then the disease-free equilibrium is globally asymptotically stable; if R0>1 then the endemic equilibrium is globally asymptotically stable.

Our proof involves using properties of M-matrices to construct a Lyapunov function that is a sum of Volterra functions.

This result subsumes a large number of results published over the last century, strengthens many of them by establishing global rather than local stability, avoids the need for any stability analyses of these systems in the future, and settles the question of whether co-existing stable solutions or non-equilibrium attractors are possible in such models: they are not.

This work was done in collaboration with David Earn (McMaster University).