Accepted Manuscript

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PII: S0378-4371(18)30472-2
DOI: https://doi.org/10.1016/j.physa.2018.04.035
Reference: PHYSA 19467

To appear in: *Physica A*

Received date : 6 August 2015
Revised date : 2 March 2018

Please cite this article as: S.-C. Wang, N. Ito, *Pathogenic-dynamic* epidemic agent model with an epidemic threshold, *Physica A* (2018), https://doi.org/10.1016/j.physa.2018.04.035

Pathogenic-dynamic epidemic agent model with an epidemic threshold

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Abstract

An agent model of epidemic spreading is proposed. When a susceptible agent is exposed to pathogen levels above its specified infection-tolerance threshold F, its state changes to infected, where a pathogen is a virus, microparasite, or any other disease-causing organism or material. The spreading sources of pathogens are the agents that are in the infected state. The growth and decay of a pathogen in an infected host obeys a given function, $f(t)$. This function increases linearly in the early period of infection t_1, and then decreases linearly to zero in the latter period t_2. The simulation results show that as the agent density increases, the model undergoes a phase transition from a local epidemic phase to a pandemic phase. For immobile agents, transition density ρ_C equals transition density ρ_P of the corresponding site percolation model. For random-walking agents, the transition density decreases as $\rho_C(U) \approx \rho_P \times U^{-0.3}$, where U denotes the average path length of the walking agent during the period $(t_1 + t_2)$. This model provides a reliable alternative to the standard SIR model, which is a simple compartmental model of susceptibility, infection, and pathogen removal. Moreover, it can predict epidemic phenomena using fact-based parameters.

Keywords: Attack rate;pathogen shedding;sojourn time of disease; super-spreading.

1. Introduction