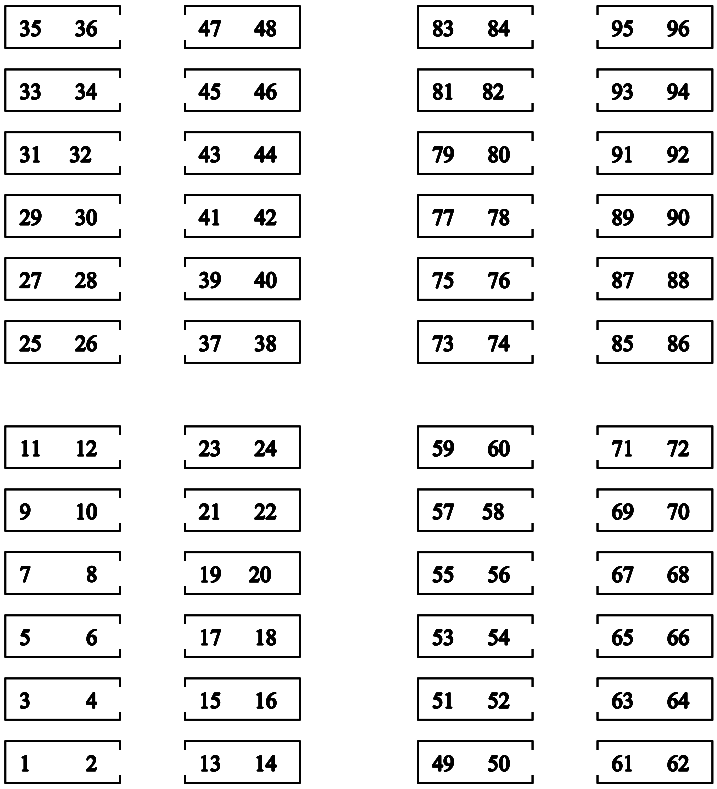
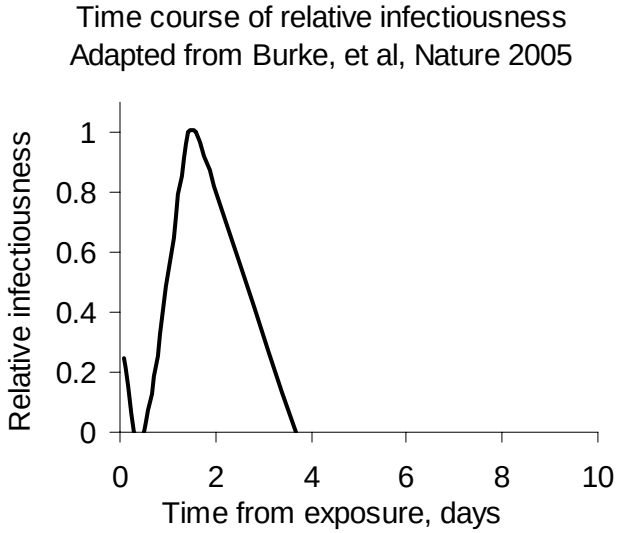
Effects of contamination of different caregiver classes on dissemination in large facilities

A flexible, agent-based model incorporating multiple caregiver classes and infectiousness that varies over time was constructed. The model was configured to emulate a 96 bed inpatient facility with 48 nurses (three shifts of 16), 12 physicians (8 “ward physicians,” who see 12 patients each day, and 4 “specialists,” who see 24 patients each day).

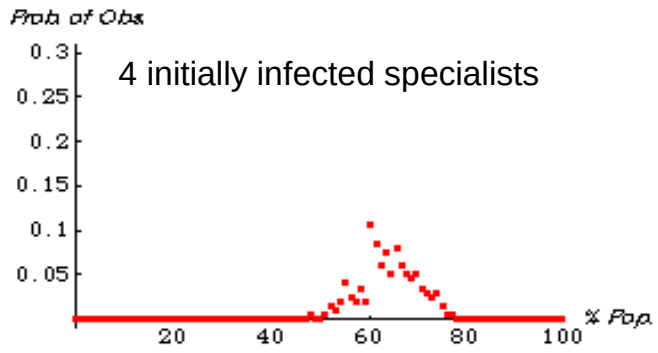


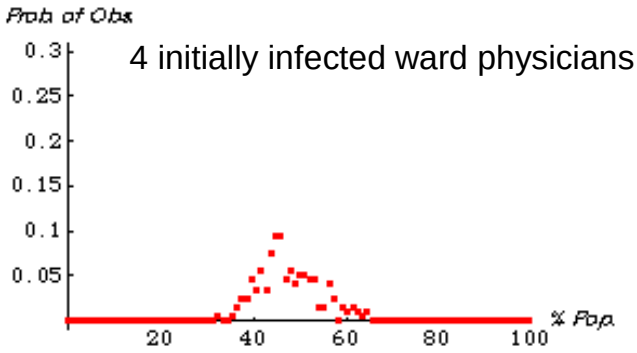
“Infectiousness” was modeled as having a biphasic time course: an initial low risk following contact with an infectious patient (corresponding to viral carriage on hands or fomites). This is followed by a more contagious period, governed by a time course loosely adapted from Burke et al, Nature, 2005:

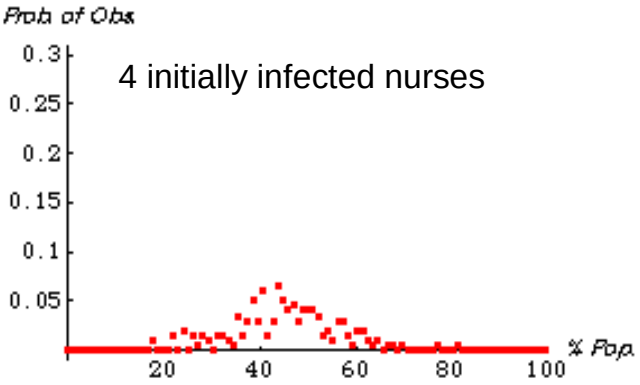


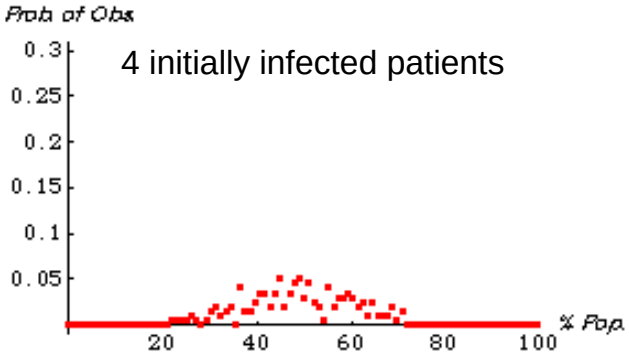
We examined the anticipated effect on dissemination of 4 infected specialists, 4 infected physicians, 4 infected nurses, and 4 infected patients on dissemination of the pathogen through the facility. To emphasize the dynamics of the processes, we modelled a one-week period of observation, a 40% chance that a fully infectious individual will infect another during close contact, and a 1% chance that a surface-contaminated individual will infect another individual on their subsequent contact.

Results are presented as the probability (y-axis, Prob. of obs) of observing a given fraction of the patient population (x-axis, % Pop.) becoming positive over the selected period of observation (one week). Thus, the model generates the probability distribution for a given fraction of the population becoming contaminated under specified spatial, initial prevalence, and dynamic conditions; data points in the upper right-hand quadrant of each panel reflect a higher probability of more extensive pathogen dissemination.









Implications

These data demonstrate that detailed agent-based models of large healthcare facilities that account for every caregiver: patient interaction, each level of spatial complexity, variable infectiousness, and different “modes” of transmission are computationally feasible. It is both intuitively evident and suggested by these models that different groups of caregivers represent different levels of “threat” if infectious. The ability to quantitate differences in effective threat could prove useful in designing policies for personnel allocation and surveillance testing.