To meet, greet or retreat during influenza outbreaks?

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When influenza pandemics arrive, the specter of disease spread through person-to-person contact can mean that schools close, hand sanitizer sales rise, and travellers stay home. But is severing social and business interactions with our neighbors really better than taking a chance on getting sick?

"Infectious disease can mean making trade-offs between the risks and rewards of meeting others," says Eli Fenichel, an Arizona State University scientist. "It's critical that we more clearly understand the role that human decisions play in transmitting disease."

Fenichel, a professor in ASU's School of Life Sciences and lead author, is one of five ASU scientists in a transdisciplinary working group that has developed a better model for understanding the role of adaptive human behavior in the spread of disease. The group's work appears in this week's online edition of the journal Proceedings of the National Academy of Sciences (*PNAS*).

Mathematical models are commonly used to help to forecast diseases and to develop science-based approaches to improve public health. However, while behavioral change has been a primary human defense against disease since the plagues of the Middle Ages, behavior change has only recently caught the attention of epidemiologists charged with forecasting disease outbreaks and providing scientific guidance on public health policy.

In this PNAS study, the authors point out that traditional epidemiological models assume that peoples' behaviors remain constant when faced with disease risk, and don't allow accurate assessment of public health decisions that encourage behavior change or "social distancing" policies.

In an outbreak of severe disease, epidemiologists rely on a measurement called "R0" or R-naught to quantify the transmissibility of a virus or other pathogen in a population and to determine vaccination or treatment programs. According to the authors' model, R0 alone is an unreliable measurement when disease risk alters human behavior.

Fenichel says that people place different values on interpersonal relations based on a variety of considerations, and how they act will depend on that value. "Behavioral restrictions can function as a tax on interactions and need to be considered," Fenichel says. "For example, a suggestion by health officials to 'fist bump,' rather than shake hands is good in informal situations. But if you have a job interview that behavior might be costly."

Further, notes coauthor Carlos Castillo-Chavez: "Different people from different cultures respond differently to disease threats. As citizens of a global village, we must better understand the collective behavior and individual decisions people make when faced by the risks of disease." Castillo-Chavez is a professor in the School of Human Evolution and Social Change in ASU's College of Liberal Arts and Sciences.

The new model accounts for tradeoffs that people make when weighing the risk of exposure to illness versus the benefits of interacting with other people. The benefit of good health is only one part of an overall index of satisfaction or "utility" or "wellbeing." This is especially true when most people don't expect any permanent side-effects from illness.

How does this play out at a societal level? In a simulated outbreak, a small increase in the price of interpersonal contact lowers the peak prevalence of the disease slightly. Slightly fewer people become infected and social utility is increased. Further increase in the price of contact, which causes individuals to make even fewer contacts, can prevent even more people from getting sick; however, this can decrease the overall benefits to society.

"Our model allows us to include behavior and shows how behavioral incentives can shape the dynamics of a disease," says Fenichel.

The researchers hope that their modeling framework helps in the creation of more effective and lower cost public health responses to infectious disease.

"This work should offer a novel approach to the challenging task of capturing dynamic population behavior in infectious disease transmission models," says Gerardo Chowell, a mathematical epidemiologist in ASU's School of Human Evolution and Social Change and researcher with the Fogarty International Center at the National Institutes of Health.

The research for the PNAS publication was conducted by an interdisciplinary group of epidemiologists, economists, ecologists, and mathematicians – all part of the SPIDER (Synthesizing and Predicting Infectious Disease While Accounting for Endogenous Risk) Working Group at the National Institute for Mathematical and Biological Synthesis (NIMBioS).

"This work points out the importance of including individual behaviors, based upon personal economic decisions, in analyzing social responses to diseases," says NIMBioS Director Louis Gross. "The SPIDER Working Group's new mathematical framework that incorporates feedback responses between individuals and their perception of disease and economic risk is a highly useful method to evaluate public health policies with a level of generality that is not readily available from more complex computational models."

More information: Fenichel EP et al. Adaptive human behavior in epidemiological models. *Proceedings of the National Academy of Sciences*. Online Early Edition, week of March 28, 2011.

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