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US control strategies may make flu epidemics worse, study shows

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Regular as clockwork, the flu arrives every year. And, according to the national Centers for Disease Control and Prevention, 5 to 20 percent of the U.S. population on average will come down with it. About 36,000 people will die.

But among health experts, a bigger concern than the seasonal flu is an outright flu pandemic, such as a human strain of avian flu. And officials say it is not a question of if such a health crisis will come but when. Are we prepared? In a word, say three UCLA researchers, no.

In a report to be published in the peer-reviewed journal *PLoS Computational Biology* and currently available online, Sally Blower, a professor at the Semel Institute for Neuroscience and Human Behavior at UCLA, and Romulus Breban and Raffaele Vardavas, postdoctoral fellows in Blower's research group, used novel mathematical modeling techniques to predict that current health policy — based on voluntary vaccinations — is not adequate to control severe flu epidemics and pandemics unless vaccination programs offer incentives to individuals.

According to the researchers, the severity of such a health crisis could be reduced if programs were to provide several years of free vaccinations to individuals who pay for only one year. Interestingly, however, some incentive programs could have the opposite effect. Providing free vaccinations for entire families, for example, could actually increase the frequency of severe epidemics. This is because when the head of the household makes a choice — flu shots or no flu shots — on behalf of all

the other household members, there is no individual decision-making, and adaptability is decreased.

While other models have determined what proportion of the population would need to be vaccinated in order to prevent a pandemic, none of these models have shown whether this critical coverage can actually be reached. What has been missing, according to Blower, a mathematical and evolutionary biologist, is the human factor.

The human factor involves two biological characteristics, "memory and how adaptable people can be," Blower said. "These characteristics drive human behavior."

Blower and her group used people's attitudes toward the seasonal flu to construct their model. With seasonal flu, protective immunity — a flu shot — lasts only one year. Thus, individuals must decide each year whether or not to participate in a vaccination program.

The model Blower's team developed is inspired by game theory, used in economics to predict how non-communicating, selfish individuals reach a collective behavior with respect to a common dilemma by adapting to what they think are other people's decisions. The group modeled each individual's strategy for making yearly vaccination decisions as an adaptive process of trial and error. They tracked both individual-level decisions and population-level variables — that is, the yearly vaccine coverage level and influenza prevalence, where prevalence is defined as the proportion of the population that is infected. The individual-level model was based on the human biological attributes of memory and adaptability.

"We assume that the decision of each individual is based upon self-interest, that people wish to avoid coming down with the flu, preferably without having to vaccinate," said Breban.

It is the adaptive decision-making by the individual, the researchers say, that may be an important and previously overlooked causal factor in driving influenza epidemiology.

"Including cognitive and personality factors into epidemic models can dramatically change our understanding of why flu epidemics occur." said Vardavas.

Source: Public Library of Science