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Flu outbreaks modeled by new study of classroom schedules

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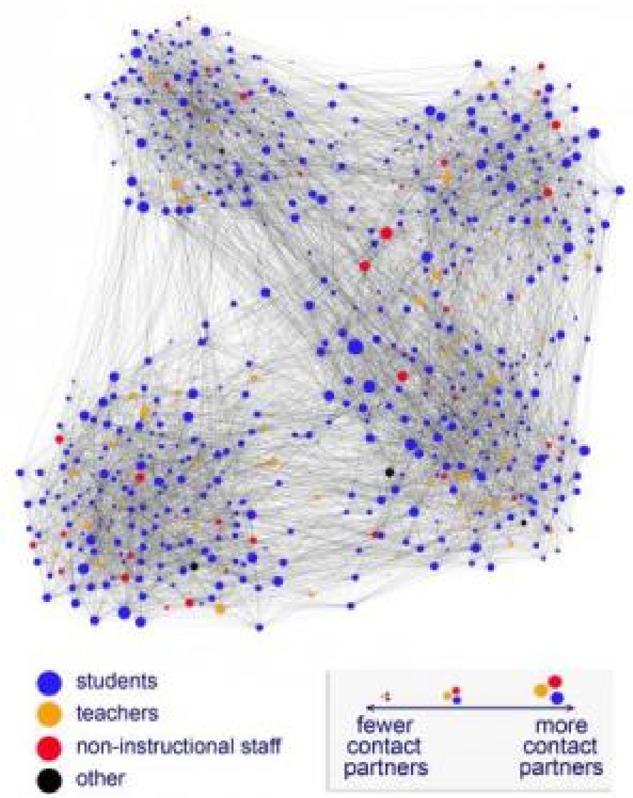

Using high-school schedule data, researchers have developed a low-cost but effective method to model disease networks and to determine how to focus disease-control strategies based on which individuals are most likely to spread the infection. Credit: Salathé lab, Penn State University

Classroom rosters combined with human-networking theory may give a clearer picture of just how infectious diseases such as influenza can spread through a closed group of people, and even through populations at large. Using high-school schedule data for a community of students, teachers, and staff, Penn State University's Marcel Salathé, an assistant professor of biology, and Timo Smieszek, a post-doctoral researcher, have developed a low-cost but effective method to determine how to focus disease-control strategies based on which individuals are most likely to spread the infection.

The results of the study are being highlighted this week as an "Editor's Pick" in BioMed Central's open-access online journal *BMC Medicine*. The journal also is publishing a commentary on the study written by Gerardo Chowell, a member of the editorial board of *BMC Medicine* and an associate professor at Arizona State University, and Cecile Viboud. Both Chowell and Viboud are Epidemiology and Population Studies researchers at the U. S. National Institutes of Health.

The team's new findings build on earlier research in Salathé's lab addressing the challenge of counting the number of disease-spreading, face-to-face interactions within a closed group of people. "Theoretically, we know that people come into contact with many other people, that interactions vary in length, and that each contact is an opportunity for a disease to spread via small droplets that spread from the nose or mouth of one individual to another," Salathé said. "But it's very tedious and unreliable to ask people, 'How many different people have you been in contact with today, and for how long?' We knew we had to figure out the number of person-to-person contacts systematically."

In a 2010 research study, Salathé and his team asked volunteers at a high school to spend one school day wearing matchbox-sized sensor devices —called motes—on lanyards around their necks. Like a cell phone, each mote was equipped with its own unique tracking number, and each mote was programmed to send and receive radio signals at 20-second intervals to record the presence of other nearby motes. Volunteers then were asked to simply go about their day by attending classes, walking through the halls, and chatting with other people. At the end of the day, Salathé's team collected the motes and recorded how many mote-to-mote interactions had occurred, and how long each interaction had lasted.

Now, in their new study, Salathé and Smieszek have studied and recorded possible disease-spreading interactions with a different system. "Using motes is expensive and tedious," Smieszek explained. "We knew that for larger-scale and more-numerous studies to be feasible in the real world, we had to find a simpler way to get data about how people in communities interact. That's where classroom schedules came in." The team members gathered data from classroom rosters and formulated a "collocation rank"—the cumulative time each individual is potentially exposed to other individuals—for all students, teachers, and staff members at a high school. These collocation ranks were calculated from information about each class taught at the school—which teacher taught the class, the room in which the class was taught, the period of the class, and the number of students who were enrolled in the class. "As you might expect, students had many more potential exposures than teachers, while janitors and office workers, who tend to work alone without many close interactions, had even fewer," Smieszek said.

The team members then compared their new classroom-schedule data to a computer model they had developed from the earlier motes study. Salathé explained that the motes study can serve as a highly reliable model of real-world interactions against which other data-collection methods can be compared for accuracy. "Data from the motes were collected systematically; all face-to-face interactions and the length of those interactions were recorded," Salathé said. "On the other hand, classroom data is somewhat fuzzier because it doesn't provide any information about between-class interactions, bathroom breaks, and possible absences. However, we found that when we compared results from the two data-collection systems, the difference was minimal. In other words, we have shown that classroom schedules can paint a fairly accurate picture of the frequency of person-to-person interactions, of which individuals have the most person-to-person contacts, and of the likelihood that disease will spread in the event of an outbreak."

Salathé and Smieszek hope that the classroom-schedule method of studying infectious-disease networks can be used in a number of ways. For example, if health officials need to ration limited doses of a new vaccine, schedule data could be used to determine which individuals have the most disease-spreading interactions. In addition, health officials could use information about more-susceptible individuals to target campaigns that raise awareness about vaccinations. "Ideally, all individuals should be vaccinated against an infectious disease," Salathé said. "But 100 percent vaccination is often not realistic, so we instead rely on 'herd immunity'—a population-level immunity that occurs when a critical mass has been vaccinated." The team members also hope that a similar system could be developed to study other disease networks; for example, universities, workplaces, or even communities at large.

"One of the major obstacles for researchers studying the spread of infectious disease is figuring out how to determine how networks are structured and which are the highest-risk individuals," Smieszek added. "Methods that rely on network information that can be gathered with motes or surveys are expensive and involve a lot of coordination of volunteers. Our method is both cheap and simple, and is reliable and reflective of real patterns."

Provided by Pennsylvania State University

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