# Using Within-School Contact Networks to Understand Influenza Transmission

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J Graham

As new pathogens and influenza strains emerge, large-scale epidemic simulation models can be used to predict epidemic spread and compare intervention strategies. Previous studies have demonstrated that school closures can reduce transmission, though this can also be costly to individuals and society. Because schools do play an important role in the transmission of infectious disease, a better understanding of the transmission process within schools might allow scientists to plan more effective interventions.

In most epidemic simulation models, social contact behavior is approximated by random mixing between individuals within classrooms, schools, workplaces, and homes. This assumes that individuals contact other mixing group members with equal probability. But in reality, students spend more time and have more frequent contact with their close friends. In order to better understand how social contact networks influence influenza transmission, Vaccine and Infectious Disease Division's Drs. Gail Potter and Betz Halloran (also Public Health Science Division), along with collaborators, developed a detailed statistical model using friendship network data and a survey of contact behavior.

Potter, Halloran, and colleagues developed their model using two data sources: i) a friendship network data survey, administered in 80 American high schools, that asked students to indicate up to five best female and male friends, and ii) a contact survey, administered in two Virginia high schools, that required participants to report the average number of contacts they make during class breaks and the lunch break, the number of close friends they have in their school, and whether students sitting near them in class are close friends, classmates but not close friends, or a mix of the two. The researchers then used this data to develop a complex model that would account for students being more likely to have increased contact with friends, but also contact other students in their classes and in the school.  Their contact network model also incorporates classroom structure and longer durations of contacts to friends than nonfriends.

Next, simulation studies were performed to compare disease transmission over the contact network model to transmission under a comparable random mixing scenario. The within-school contact

network model estimated a smaller probability of epidemic, smaller final size, and later peak date than a random mixing model. The two models also produced substantially different estimates of intervention effectiveness for two intervention strategies the authors considered. The first was a targeted antiviral prophylaxis intervention, in which antiviral medication is given to sick students and their contacts. The second is a reactive grade closure strategy, in which a grade closed the day after one student in that grade shows symptoms. Under the targeted antiviral prophylaxis intervention, the people prioritized for prophylaxis and treatment are those who are repeatedly exposed through increased contact to infectious individuals, so the contact network model may produce more accurate predictions of epidemic outcomes than random mixing. When compared to the simulations from the contact network, the random mixing model was found to overestimate how effective school grade closures would be in reducing the probability and final size of an epidemic. The authors performed additional simulation studies exploring which friendship network structures were most relevant to the transmission process and validating their model. Altogether, the authors recommend further exploration into how friendship network structures influence the transmission of infectious disease, as this could influence and update policy recommendations based on previous random mixing models.

Potter GE, Handcock MS, Longini IM, Halloran ME. 2012. Estimating within-school contact networks to understand influenza transmission. *Annals of Applied Statistics*. 6(1): 1-26; doi: 10.1214/11-AOAS505
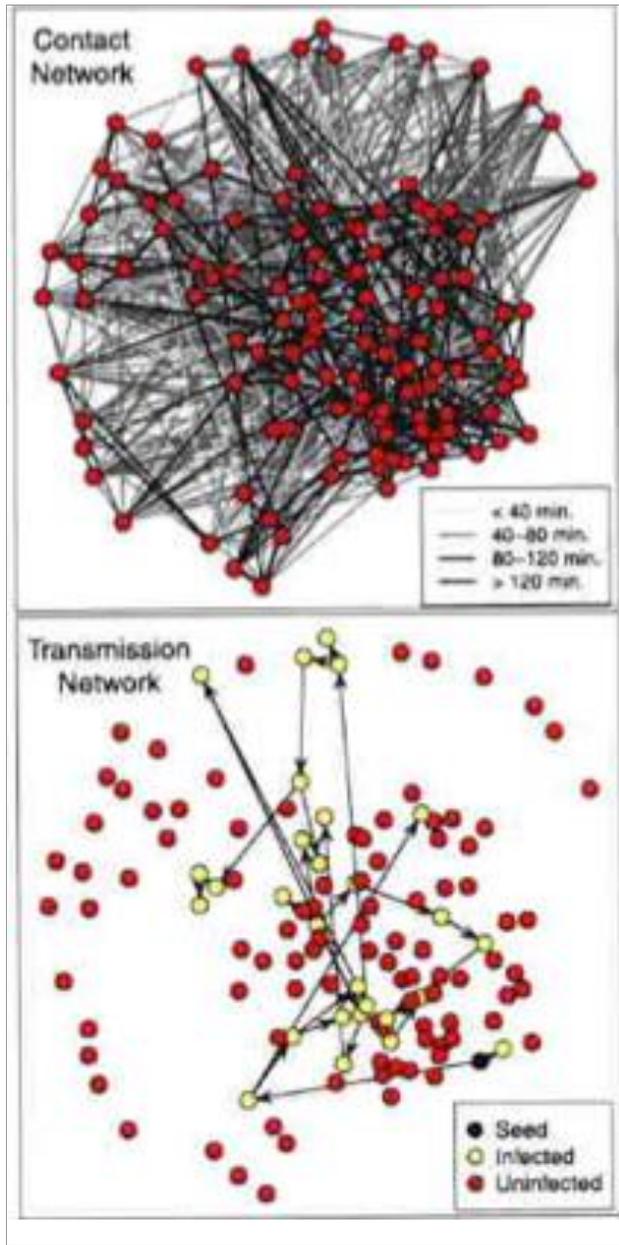
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Top, simulated contact network based on the friendship network. An edge represents one or more contacts during the day, and the shade of gray represents the total duration of contact between each pair. Bottom, simulated transmission network based on the contact network. The seed of the epidemic is black; the color of other nodes indicates whether they became infected during the epidemic or not.