**Epidemiology**

**Infectious personalities**

Social networks catch an early glimpse of disease outbreaks

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CHANCES are your friends are more popular than you are. It is a basic feature of social networks that has been known about for some time. Consider both an avid cocktail party hostess with hundreds of acquaintances and a grumpy misanthrope, who may have one or two friends. Statistically speaking, the average person is much more likely to know the hostess simply because she has so many more friends. This, in essence, is what is called the "friendship paradox": the friends of any random individual are likely to be more central to the social web than the individual himself.

Now researchers think this seemingly depressing fact can be made to work as an early warning system to detect outbreaks of contagious diseases. By studying the friends of a randomly selected group of individuals, epidemiologists can isolate those people who are more connected to one another and are therefore more likely to catch diseases like the flu early. This could allow health authorities to spot outbreaks weeks in advance of current surveillance methods.

In a report just posted on arXiv, an online repository of research papers, and which has been submitted to the *Proceedings of the National Academy of Sciences*, Nicholas Christakis from Harvard University and James Fowler from the University of California, San Diego put the friendship paradox to good use. In a trial carried out last autumn, they monitored the spread of both seasonal flu and H1N1, popularly known as swine flu, through students and their friends at Harvard University.

Dr Christakis and Dr Fowler selected a random group of 319 undergraduates and asked each to nominate up to three friends. Using these names, they collected another group of 425 friends. As the friend paradox predicts, the second group were both more popular (named more times by the random group) and more central to the connections among Harvard students. Flu infections were monitored from September 1st 2009 to the end of December by identifying those diagnosed by the university's health services and by e-mail responses to a twice-weekly health survey. Overall, 8% of the students were formally diagnosed with the flu and 32% were self-diagnosed. But the infection rate peaked two weeks earlier among the group of more-connected friends. Their social links were indeed causing them to get infected sooner.

**Early warning**

As this result came with the benefit of hindsight, the researchers tried to come up with a real-time measure that could potentially provide an early warning sign of an outbreak as it began to spread. To do this they went back to the beginning and compared diagnoses between the two groups on a daily basis for each of the 122 days of the study. A significant difference between the two groups was first detectable a full 46 days before visits to health services peaked for the random group. For those with self-
reported symptoms, there was a noticeable difference 83 days before the peak in self-reported symptoms.

These early results are impressive. Currently, the methods used to assess an infection by America’s Centres for Disease Control and Prevention lag an outbreak by a week or two. Google’s Flu Trends, which monitors millions of queries submitted to the giant search engine for the occurrence of flu-related keywords, is at best contemporaneous with an outbreak. Dr Christakis and Dr Fowler suggest that a hybrid method might be developed in which the search queries of a group of highly connected (ie, popular) individuals could be scanned for signs of the flu.

Although the technique has so far only been demonstrated for the flu and in the social milieu of a university, the researchers nevertheless think that it could help predict other infectious diseases and do so on a larger scale, such as in cities and across regions. Nor should it be difficult to implement. Public-health officials already conduct random sampling, so getting the participants to name a few friends too should not be onerous. When it comes to infectious diseases, your friends really do say a lot about you.