

Hub caps could cut vaccine costs

Random immunization could halt diseases and computer viruses.

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A new immunization strategy could help to prevent disease epidemics without blanket vaccination, suppress computer viruses, and even break up terrorist networks. At least, so say its designers.

All you need do is choose people at random and treat some of their friends, suggest Reuven Cohen, of Bar-Ilan University in Ramat-Gan, Israel, and his colleagues¹.

"Friends just aren't normal," agrees Mark Newman, a networks specialist at the Santa Fe Institute in New Mexico. "Friends are, by definition, friendly people, and your circle will be a biased sample of the population because of it."

Grid lock

When a disease is caught by person-to-person contact, as are sexually transmitted viruses, it spreads through a social network that looks like a disorderly grid. Each person represents a node in the grid, linked to others with whom they have had potentially infectious contact.

In recent years, researchers have realized that disease spread can depend strongly on what this network looks like - on how the nodes are linked.

Many human networks - including some webs of sexual contacts and the Internet - seem to take on a form called scale-free. Here a few very highly connected nodes, dubbed 'hubs', bind the network together. Hubs are shortcuts between any two nodes, giving rise to the small-world effect popularized in the notion of us all being a maximum of six degrees of separation from anyone else.

In such networks, infection does not travel as traditional epidemiological models imply. Even slow-spreading diseases can reach epidemic proportions. Epidemics were long thought to occur only if the dissemination rate exceeds a certain threshold value.

In principle, epidemics in a scale-free network can be quashed by identifying and immunizing just the hubs. This is an appealing method, as it cuts costs.

In practice, however, hubs can be very hard to find. As a result, some epidemics, such as the spread of computer viruses and measles, currently rely on random immunization - virtually the entire population is treated.

Mate choice

Cohen and colleagues looked for a strategy that could immunize just a few individuals without mapping the network exhaustively. They conclude that, rather than simply immunizing random individuals, it might be more effective to treat a random selection of the acquaintances of individuals picked at random.

This sounds as if it leaves just as much to chance. But it doesn't. In a scale-free social network - a web of friendships, say - anyone connected to another person by a friendship tie is not representative of the average. Most nodes have very few connections. So if you know for sure that someone is part of a friendship circle, they are more likely to be a hub than is another person selected at random.

In a standard mathematical model of the spread of infectious disease, Cohen's and colleagues' strategy of random-acquaintance immunization requires only about half of a population to be treated to substantially reduce the chance of an epidemic.

"For terrorist networks," they say, "our findings suggest that an efficient way to disintegrate the network is to focus on removing individuals whose name is obtained from another member of the network."

References

1. Cohen, R., Havlin, S. & ben-Avraham, D. Efficient immunization strategies for computer networks and populations. *Physical Review Letters*, **91**, 247901, doi:10.1103/PhysRevLett.91.247901 (2003). **[Article]**



A targeted immunization strategy is cheaper than a blanket one.

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Friends just aren't normal

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