Medical Xpress

With proper planning, selective rather than mass vaccination can provide immunity against flu

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With the current outbreak of the flu season in Israel, hospitals are reporting overcrowding, and doctors are advising people who have not yet been vaccinated against flu to get their shots.

Surprisingly, however, three physicists -- one from the Hebrew University of Jerusalem and two others from the University of Michigan – have developed an unconventional, theoretical strategy for intensive but limited vaccination against infectious diseases (such as flu) that would replace the practice of mass inoculation over a prolonged period. The physicists developed their theory using a technique borrowed from quantum mechanics.

How does it work? The program is based on accelerating the natural extinction of the disease through selective vaccination.

Prof. Baruch Meerson of the Racah Institute of Physics at the Hebrew University explains the strategy:

"Consider an unfortunate situation when an infectious disease has spread over a population, and a certain portion of the population is sick. Most of the infected individuals recover from the disease and develop immunity to it. On the other hand, the infected individuals can spread the disease in the population through contacts with susceptible individuals.

"To reduce the infection spread, one can vaccinate all possible susceptible individuals. If they are all willing to be vaccinated and there is enough vaccine for everybody, the vaccination campaign will eradicate the disease with certainty. Very often, however, a large portion of susceptible individuals refuse to be vaccinated. In addition, a vaccine can be in short supply, expensive to produce, or difficult to store."

How to cope with such conditions is the problem tackled by the three physicists: Meerson from the Hebrew University and Prof. Mark Dykman and Dr. Michael Khasin from Michigan State University in the US. (Although presently working in the US, Dr. Khasin earned his doctorate at the Hebrew University.)

The researchers made use of the fact that, even without vaccination, a disease ultimately becomes extinct on its own. But for large populations, the typical time it takes for the disease to disappear by itself can be very long. Essentially, Meerson and colleagues suggested an optimal vaccination strategy that accelerates, in the maximum possible way, this natural process of disease disappearance.

In this strategy, the vaccine must be delivered to the most susceptible populations (say children in a particular class where a certain percentage of the pupils have come down with the flu) in the form of short but intensive vaccination periods, adjusted to match the "ups and downs" of waves that occur in the natural spread of infectious disease.

Also, when the disease has a seasonal variation (like the common cold), that factor must be taken into consideration in the vaccination timing calculations.

The question that still remains is why physicists took on a problem belonging to epidemiology? Meerson says that the mathematical model that he and his colleagues used in their analysis closely resembles a quantum-mechanical model that physicists use when analyzing the dynamics of microscopic particles (such as electrons) in miniature traps. By adjusting the size of the traps upwards or downwards, one increases or decreases the chances of the electrons escaping. It is this unexpected analogy that made it possible to make the surprising conclusions about the periodic vaccination protocol – that is, to show how targeted, selective vaccination can indeed limit the "escape" of infectious germs and allow the disease to die down through largely a natural process.

Meerson and colleagues have yet to model their periodic vaccination scheme using real-world data. But they say their calculations show that vaccinating just a few percent of the population could reduce the time it takes to eradicate a disease from, say, five months, to between three and four. The researchers hope to continue refining their work on this phenomenon.

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