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Influenza infection increases likelihood of bacterial pneumonia 100-fold

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It's been known for more than two centuries that pneumonia cases increase during flu epidemics.

But population-level epidemiological studies looking at seasonal patterns of influenza and pneumococcal pneumonia incidence have revealed either a modest association or have failed to identify any signature of interaction between the two.

These seemingly inconsistent observations at the personal and population scales have puzzled public health officials. Now a team of University of Michigan researchers and their colleagues have used a novel approach that they say resolves the dichotomy and shows that influenza infection increases susceptibility to pneumococcus, the most common bacterial cause of pneumonia, by about 100-fold.

An accurate characterization of the influenza-pneumococcal interaction can lead to more effective clinical care and public health measures, including influenza pandemic preparedness, according to the authors.

"The results concerning the nature of the interaction between influenza and pneumococcal pneumonia were unequivocal in our study," said U-M population ecologist and epidemiologist Pejman Rohani, senior author of a paper scheduled for online publication in *Science Translational Medicine* on June 26. "Simply put, our analyses identified a short-lived but significant—about 100-fold—increase in the risk of pneumococcal pneumonia following influenza infection."

Rohani and his colleagues created a computer model of pneumococcal pneumonia transmission that analyzed various hypotheses about the potential effects of a prior influenza infection. By challenging the model with hard data from epidemiological reports—weekly records of influenza and pneumococcal pneumonia hospitalizations in Illinois between 1989 and 2009—they were able to rank the likelihood of each hypothesis.

The clear winner was the susceptibility impact hypothesis, which proposed that individuals infected with influenza are more susceptible to pneumococcal pneumonia. The increased susceptibility to pneumonia lasts for up to a week after infection by influenza.

The researchers also looked at the fraction of pneumonia cases that could be attributed to interaction with influenza. They found that during the peak of flu season, interaction with the influenza virus accounted for up to 40 percent of pneumococcal cases. But on an annualized basis, the fraction was between 2 percent and 10 percent of cases, a relatively subtle signature that could help explain why previous epidemiological analyses failed to detect the connection, Rohani and his colleagues concluded.

"We infer modest population-level impacts arising from strong processes at the level of the individual, thereby resolving the dichotomy in seemingly inconsistent observations across scales," they wrote.

Rohani said the results suggest that the best way to reduce the incidence of bacterial pneumonia is to encourage the public to receive both pneumococcal and influenza vaccinations.

Pneumonia is an infection of the lungs that is usually caused by bacteria or viruses. Globally, pneumonia causes more deaths than any other infectious disease. In 2009, 1.1 million people in the United States were

hospitalized with pneumonia, and more than 50,000 people died from the disease, according to the Centers for Disease Control and Prevention. In 1918, at least 24 percent of those killed during the Spanish influenza pandemic showed signs of a bacterial pneumonia infection.

In the United States, the most common bacterial cause of pneumonia is pneumococcus (*Streptococcus pneumonia*), and the most common viral causes are influenza, parainfluenza, and respiratory syncytial viruses, according to CDC.

More information: "Identifying the Interaction Between Influenza and Pneumococcal Pneumonia Using Incidence Data," by S. Shrestha, *Science Translational Medicine*, 2013.

Provided by University of Michigan