UNRAVELING THE MATH OF DISEASE IMMUNITY

Bordetella pertussis | When children become infected with *Bordetella pertussis*, the bacteria damage the lining of their lungs, making it impossible to clear mucus and other microbes from their airways. Kids gasp, wheeze and cough uncontrollably, occasionally suffering seizures and brain damage.

Immunization can greatly reduce the risk of developing whooping cough, but it's only 60-90 percent effective. When pertussis resurged in Sweden despite high rates of whole cell vaccination, vaccination was discontinued, the disease became endemic and clinical trials of new acellular vaccines were conducted. Sweden introduced an acellular vaccine in 1997.

Swedish researchers collected cord blood samples from maternity hospitals along with blood samples from preschoolers, older children and adults. Those samples served as data points for a new study conducted with the help of mathematical epidemiologist Zhilan Feng and her colleagues in Sweden and at the U.S. Centers for Disease Control.

"The difficulty of this work is that immune mothers provide immunity to infants, but it decays," says Feng, a professor of mathematics. "Infection also can provide immunity, but that wanes, too. Re-infection can happen whenever immunity wanes. Our model is complicated mathematically."

To help Swedish officials determine if and when a booster vaccination might be helpful, Feng and her collaborators devised a way to calculate rates of infection by age, accounting for maternal antibodies that were passively acquired. Their results showed that children, adolescents and young adults had higher infection rates than older people.

"I believe that our results are very important in terms of understanding this disease," Feng says. "And that this kind of work can provide useful information for policy makers in identifying critical groups for vaccination."

PHOTO BY VINCENT WALTER

Zhilan Feng