News and Views – November 2014 Topic

Herd Immunity and Vaccine Duration

Some believe that the lack of vaccine boosters given to adults provides evidence that herd immunity is a myth. So let's look at this notion more closely.

What is herd immunity?

Herd immunity is the concept that when most people in a community are protected against a disease, everyone in the community is better protected. A highly vaccinated community means that fewer people are available to spread viruses and bacteria, which results in lower levels of disease. Herd immunity does not apply for diseases in which person-to-person spread is not a means of transmission, such as tetanus.

Factors that affect herd immunity

While the general concept of herd immunity is the same for all transmissible diseases, the specifics of herd immunity vary depending upon the disease and vaccine used to prevent it:

1. Ease of disease transmission — Diseases are not only spread by different routes, they are also not equally contagious. For example, if we compare influenza and Ebola viruses, both of which have been in the news, influenza is spread fairly easily from person to person by coughs and sneezes, whereas Ebola is spread by contact with body fluids of a person who already has symptoms of disease. Because influenza is more easily spread from one person to another, the number of protected people in a community needs to be higher for a community to enjoy the effects of herd immunity against influenza as compared to Ebola.
2. Vaccine effectiveness — When we think about vaccine effectiveness, we are typically discussing how well the vaccine prevents disease in the person who received it. However, vaccine effectiveness plays a role in herd immunity as well. Because the central tenet of herd immunity revolves around disease transmission, it is probably obvious that a vaccine that is highly effective at preventing disease will strengthen herd immunity. However, a vaccine can affect herd immunity in another more subtle way — some vaccines are better than others at decreasing shedding of viruses or bacteria, which reduces spread. For example, when the rotavirus vaccine was first introduced in 2006, about 50 percent of

children received it. But the vaccine caused an 80 percent reduction in diseases. This was an example of herd immunity.

When we put vaccine and disease factors together, each disease then has its own potential for the community to benefit from herd immunity. If you use the example of a ticket system, each vaccine-preventable disease, except tetanus, would be stopped in a community with only a certain limited number of “free-ride” tickets. Because some people in a community will be unable to get vaccinated for reasons such as age or health status, they will use these tickets. Likewise, people who choose not to immunize and those whose immunity is not protective will also be ticket holders. The more free-ride tickets in the community, the more likely the disease will enter the community. The diseases that can afford the fewest number of free-ride tickets before outbreaks occur are measles and pertussis. Because more and more people are asking for free-ride tickets, herd immunity has eroded and measles and pertussis outbreaks are occurring. Some authors refer to this problem as “the tragedy of the commons.”

Adults and booster doses

Adults do not require as many immunizations as children because they are often immune to the diseases of childhood. For some, it is because they are old enough to have been exposed to the disease. For others, immunity is the result of vaccinations received earlier in life. However, because children often receive booster doses, people sometimes wonder why adults do not as well. The lack of need for booster doses in adult can be for one of several reasons.

Factors affecting the need for booster doses can be divided into those related to the disease and those related to the vaccine.

Disease-related considerations

- Biology of infection — For example, measles and chickenpox require entrance and spread through the bloodstream to cause infection. Therefore, antibodies in the bloodstream can protect against subsequent infection. Typically, antibodies induced in the bloodstream after immunization are lifelong (unlike antibodies induced at mucosal surfaces), so booster doses in adulthood are not needed. In addition, these viruses do not change through time, so immune responses generated initially will remain effective years later. These types of infections tend to produce a life-long immunity. Whereas, diseases that occur at a mucosal surface (respiratory, gastrointestinal, or urogenital tracts), such as influenza and rotavirus, produce antibodies that stay at the mucosal surface and are not as long-lived in terms of the immunologic memory produced. Additionally, some pathogens change enough through time that antibodies produced at one point in time may or may not be effective during a subsequent infection, such as influenza and human immunodeficiency virus (HIV).
- Disease levels in the community — For diseases that are still common, booster doses are often not necessary because exposures are likely to occur that allow for maintenance of a protective immune response. People just don’t realize that they have been exposed. Sometimes when a vaccine first becomes available, enough of the organism is still circulating in the community that people are exposed without knowing it, leading to a

natural boosting of the immune response. However, after the vaccine has been widely used, lower levels of disease may be circulating requiring boosting by other means, such as vaccination.

- Susceptibility — Some diseases are more likely to infect certain subsets of the population. In many cases, the most susceptible groups are children. Therefore, if adults are less susceptible, they would no longer need a vaccine or a booster dose.

Vaccine-related considerations

- Durability of vaccine responses — Some vaccines induce better immune responses than others. For example, infants and children less than 2 years of age do not produce strong immune responses to the original pneumococcal vaccine, known as the polysaccharide version. However, a newer version that includes a helper protein, known as the conjugate version, allows infants to develop protective immunity.
- Effectiveness of vaccine — In some cases individuals will not respond to a dose of vaccine. For example, about 94 of 100 people will be protected after one dose of the measles vaccine whereas about 99 of 100 will be protected after two doses.

Summary

In summary, various factors make the potential for herd immunity different for each pathogen. In addition, whether or not booster doses are necessary depends upon both disease- and vaccine-specific characteristics. Therefore, the fact that booster doses are not typically necessary in adults cannot be used to prove or disprove the concept of herd immunity. A good rule of thumb when evaluating statements for accuracy is that broad, general statements often overlook nuances important in understanding a particular issue. So, while it might seem to make sense at face value that the lack of adult booster doses means herd immunity is a myth, taking time to explore the different aspects of the statement is important in sorting out whether the statement may be true.