

BEE YET

Immunity, Vaccines & Honey Bees: Part 1

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As a veterinarian, I have administered thousands of various vaccines to a variety of animals over the years. As in humans, these vaccines are typically developed over decades of research and trials and are administered according to the individual's risk, including age, immunological status, potential exposure risk, economic feasibility, and geography. As a veterinarian, I have been vaccinated for a few more things than the average person due to my occupational risk. Rabies, for example. Yes, there is a human vaccine. Most veterinarians are vaccinated for Rabies because in our profession, we are likely to be exposed directly to this disease, a disease with nearly a 100% mortality rate. A nearly 100% mortality rate? Wow, why isn't everyone vaccinated?

The answer is three-fold:

1. Because we vaccinate our canines for Rabies. By controlling this zoonotic disease in the domestic dog population (which is the most common exposure risk for humans worldwide), we greatly eliminate exposure risk in humans. Unfortunately, in developing countries with little or no canine vaccine programs, about 60,000 people world-wide die each year of Rabies.
2. Because we have very effective ther-

apeutics that can prevent the disease after exposure, if applied early. Due to the longstanding, successful public education on Rabies, most folks know that if you are bitten by an animal, it should be examined for Rabies, and you should see your doctor asap. Even if you are bitten by an animal that is positive for Rabies, we have a combination of therapeutic vaccines and immunoglobulins (antibodies) that will prevent the virus from taking hold.

3. Because of #1 and #2, the actual risk vs. benefit does not support the use of the vaccine in the general human population. Possible side effects of the vaccine outweigh the actual risk. On average, in the US, only zero to three people die of Rabies annually, usually due to bat exposures. You are at least nine times more likely to be killed by lightning (source weather.gov).

Vaccines can be a wonderful tool in the control of infectious diseases, when applied appropriately.

Types of Immunity

To understand how vaccines work, it is important to understand how our immune systems work. I'll do my best to give you a brief synopsis.

There are three arms of defense in our immune systems, innate immunity, humoral immunity, and cellular immunity. Innate immunity is our first line of defense against any pathogen. Innate immunity includes the natural barriers of our body like our skin (or exoskeleton if you are a honey bee), respiratory and gut linings, natural microbiota, as well as non-specific reactions to any foreign invader, including certain inflammatory pathways, fever, enzyme activity, and our white blood cells recognizing and eating up non-specific, irregular stuff.

Humoral immunity largely involves antibody production that can help the body identify and eliminate pathogens from the body. Cellular immunity largely involves special blood cells called T-cells that recognized infected cells and can target the cells and/or pathogens within them. Both humoral and cellular immune systems have the ability to "remember" previously encountered pathogens and are therefore much more effective in eliminating the specific pathogen in any future encounters. "Immunity" has been achieved!

How we obtain immunity can also vary. We classify immunity obtainments as natural or acquired. Natural immunity can be passive or active. Passive, natural immunity comes from our mommas, usually passed through the placenta or milk. Passive natural immunity helps to protect fragile newborns from the rough and tough world, but it may not last very long. Conversely, active, natural immunity, we earn all on our own. We "naturally get" the disease. When infected with a pathogen we may or may not become ill and assuming we survive, our bodies typically develop immunity. Active, natural immunity usually provides a robust and often long-lasting immune response, but in some cases, there is a pesky risk of death, particularly with immune-compromised patients and/or diseases with high mortality rates.

Acquired means something outside of yourself has been given to you to help develop immunity. Acquired immunity can also be passive or active. Acquired, passive immunity occurs typically when a patient is given pre-formed antibodies as a therapeutic to help fight off a disease. Acquired, active immunity occurs when a patient is given a vaccine and develops immunity to the particular pathogen.

How Vaccines Work & Types of Vaccines

Vaccines are typically administered using oral, injectable, or nasal routes. Most vaccines have been developed for viral diseases, but we also can develop vaccines for some bacterial and parasitic infections. Vaccines can be used as a tool to accomplish three things:

1. Eradication of a disease. This means there is no active disease left in the population on Earth! This is an extremely rare accomplishment, which has only occurred twice in the history of man or beast out of the thousands of known diseases that inflict us. Most people would guess and guess correctly that small pox is one of them. But the second one is a bit tougher.... It's Rinderpest...tricky, huh? Rinderpest is/was a cattle disease that was absolutely devastating to the cattle population particularly in Africa and therefore devastating to the human food supply and econ-




disease means that the disease is still present in a population, but it is reduced and manageable within the health care system, has a relatively low mortality rate, and/or has become endemic. This is the typical expectation and usually what happens with most diseases and vaccine use.

Vaccine forms have varied and evolved over the years. "Live" vaccines are typically "attenuated", which means the vaccine contains a weakened form of the actual pathogen. Attenuated live vaccines have many advantages in that they provide a robust immune response of both humoral and cellular immunity, but since the vaccine is still a form of the pathogen, there is a low risk of the disease developing and live vaccines are not recommended to be given to immunocompromised patients. Examples of live attenuated vaccines include flu vaccines, MMR, polio, smallpox, and Chicken pox/Shingles.

Some vaccines are in the "killed" or "inactivated" form. These vaccines may induce a less robust immune

response but are safer since the pathogen is killed and there is no risk of disease development. Killed vaccines are recommended in immunocompromised patients and with pathogens that are extremely virulent. For example, Rabies is a killed vaccine, as is the vaccine in development for American Foulbrood (AFB). For good reason!

Even with rigorous trials, vaccines are not always perfect. All vaccines can have side effects. Sometimes they are taken off the market for one reason or another, including safety concerns, lack of efficacy, and economics, or better, safer vaccines are developed to replace them. The risk vs. benefit of a vaccine must be weighed with a consult from a patient's doctor.

Next month I will discuss how our knowledge of immunity and vaccination can be applied to control honey bee diseases along with an interview from Dr. Annette Kleiser, PhD, CEO, and founder of DALAN Animal Health, who is a key researcher in the development of honey bee vaccines. 

omy. What's next? Well... we're still working on Polio and maybe the Guinea Worm.

2. Elimination of a disease. Elimination means a previously existing disease is no longer present in a population in a certain geographical area, but it's still present in other parts of the World. Examples of diseases eliminated from the United States include Yellow Fever, Polio, and Malaria. This does not mean that the disease cannot re-emerge in the area if precautionary measures are ignored.
3. Control of the disease. Control of a



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