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VACCINES

What is a vaccine?

The word *vaccine* comes from the discovery of an English country doctor, Dr. Edward Jenner. Dr. Jenner discovered that people given a preparation or *vaccine* of material from the common cattle disease, cowpox or *vaccinia*, developed only a mild skin infection, but when those *vaccinated* individuals were exposed to the deadly smallpox virus (a virus closely related to cowpox) they remained healthy. They were *immune*. More than one hundred years after Jenner's findings, the great French scientist Louis Pasteur and his colleagues found that they



could protect animals and people against a variety of diseases including rabies by administering injections of the infectious microorganism in an altered form. The two main alterations of these microorganisms were "inactivated vaccines" using killed virus or "attenuated vaccines" using still living virus but changed into a harmless form.

What is "immunity"?

Immunity is a complex series of defense mechanisms by which an animal is able to resist an infection or, minimally, resist disease and the harmful consequences of the infection. The main components of these defenses are the white blood cells, especially lymphocytes and their chemical products, antibodies and cytokines such as interferon. All infectious disease organisms (viruses, bacteria, protozoa, fungi, etc.) have specific components called *antigens*. These antigens cause lymphocytes to respond in a specific way such that each antigen stimulates the production of a mirror-image *antibody* as well as non-antibody responses called *cellular immunity*. Immunity has memory, so that a subsequent exposure to the same antigen results in a much more rapid response. This rapid "boost" of immunity usually stops the new infection before it can cause illness. The animal is then said to be "immune" against this infection. Such immune memory can fade with time, sometimes quite rapidly, depending on the specific antigen-antibody relationship.

Immunity is not absolute. Immunity can sometimes be overcome when there is an overwhelming exposure to a high dose of a virulent or particularly harmful strain of the microorganism or when the animal is unduly stressed or its immune system is otherwise depressed known as *immunosuppression* by other infections or certain drugs.

What is a modified-live vaccine?

In a modified-live or live-attenuated vaccine the causative organism (virus, bacterium, etc.) has been altered so that it is no longer harmful or *virulent* but upon injection or other administration it will stimulate protective immunity.

What is a killed vaccine?

The organism has been killed or *inactivated* to render it harmless. Killed vaccines often need a helper or *adjuvant* included in the vaccine to stimulate a longer-lasting immune response.

Which is better: a live or killed vaccine?

Both have advantages and disadvantages. Your veterinarian takes many circumstances into account in making the choice.



Why are vaccines administered by injection?

Some vaccines are given locally, for example into the nose, but most require injection so that the maximum take-up of vaccine by the white cells and stimulation of the immune system is achieved. Some vaccines are injected *subcutaneously* or just under the skin, others are injected into the muscles or *intramuscularly*. Injections look easy but there are a number of precautions a veterinarian is taking.

Which vaccines are needed in dogs?

Depending on your locality some infections may be more or less likely. Your veterinarian will assess the relative risks based on your circumstances and advise you accordingly. The range of vaccines available includes: *rabies*, *distemper*, *adenovirus/ infectious canine hepatitis*, *parvovirus*, *leptospirosis*, *parainfluenza*, *coronavirus*, *Lyme disease*, and *Bordetella bronchiseptica* (see *Kennel Cough*). For details on these diseases see the specific topic. These vaccines are often available in combinations given in one dose. These combination vaccines are convenient and avoid extra injections for your dog, but sometimes separation of vaccines is advisable. Your veterinarian will advise you on the appropriate vaccines for your pet based on your dog's specific lifestyle requirements.

“Core” Vaccines – Recommended for all puppies and dogs by the American Animal Hospital Association (AAHA) Canine Vaccine Task Force

- Canine distemper virus
- Canine parvovirus
- Canine adenovirus-2
- Rabies virus

“Non-Core” Vaccines – Recommended for puppies and dogs in special circumstances, dependent on the exposure risk of an individual dog by the American Animal Hospital Association (AAHA) Canine Vaccine Task Force

- Distemper-measles virus
- Leptospira spp.
- Borrelia burgdorferi or Lyme disease
- Canine parainfluenza virus
- Bordetella bronchiseptica or “Kennel Cough”

What is maternal immunity?

Newborn animals have not yet had a chance to make their own immunity so they need protection against infections present in their environment. They receive this immunity from their mother, partly across the placenta while in the uterus with most of the maternal antibody transferred to them in the first milk or colostrum. Maternal immunity is only temporary. It declines steadily over the first few weeks of life and is largely gone by twelve weeks. The rate of decline is variable depending on many factors.

Why is more than one dose of vaccine given to pups?

There are two reasons. First, without complicated testing it is impossible to know when a pup has lost the immunity it gets from its mother called *maternal immunity*. An early decline in a puppy's maternal antibody can leave it susceptible to infection at a very young age but a strong maternal immunity can actually interfere with early vaccination (see *Vaccination Failure*). Second, particularly with killed vaccines, the first dose is a "priming" dose, and the second dose is needed to boost the response to a higher, longer-lasting level of immunity.

Why does my dog need to be revaccinated?

In most properly vaccinated dogs, the immunity should last more than a year, and often several years. However, immunity does decline with time and this decline rate varies with individuals. To maintain the best immunity in a reasonable way, revaccinations have proven very successful. Because improvements are continuously made in the vaccines we use, some do not need to be given so often, depending on individual circumstances of the pet. Most dogs with low-risk lifestyles will be vaccinated every three years with the "core" vaccines and then as needed for any "non-core" vaccines. Your veterinarian will discuss the need and frequency of booster vaccinations for your dog based on your pet's needs and lifestyle.

How long does it take for a vaccine to produce immunity?

Within a few hours of vaccination the earliest phases of the immune response are being stimulated. It usually requires ten to fourteen days before a reasonable level of protection is established. Killed vaccines may not provide adequate protection until after the second dose. Also in young puppies maternal antibody may hinder protection until later in the vaccine series. Therefore it is advisable to keep a recently vaccinated pup away from dogs or pups of unknown vaccination history until it has finished its vaccination course.

What happens if my dog is sick when vaccinated?

The veterinary check-up prior to vaccination and sometimes blood tests pre-vaccination help prevent this situation. In most cases it would not have disastrous consequences, but it is important that an animal is healthy when vaccinated, to ensure proper development of immunity.

Will vaccination make my dog sick?

It is not unusual to detect some lethargy in the day or so after vaccination. In the case of killed vaccines containing an adjuvant, some thickening or lump formation may occur at the vaccination site. If this is painful or persists for more than a week or so with no decrease in size, consult your veterinarian. A few dogs will develop more severe reactions that are forms of hypersensitivity (*allergy*). These will usually occur within minutes but may be delayed for a few hours. The dog may have difficulty breathing, salivate, vomit, and have diarrhea. In these situations consult your veterinarian immediately.

Do vaccines provide 100% protection?

Vaccines have been highly successful in protecting the majority of dogs against diseases such as distemper that were once common but now rare, but there are situations in which the immunity conferred by a vaccine may be overcome and a vaccinated dog may still develop disease. In such cases the disease is generally milder than it would have been had the dog not been vaccinated. Some causes for apparent “vaccine failure” are:



Maternally derived antibodies – As mentioned above, when a puppy is born and after it suckles its mother, it acquires a proportion of any antibodies that the mother has. So a well-vaccinated female will confer antibodies to the diseases she has been vaccinated against and any others she has acquired naturally to her puppies. Such antibodies protect the pup against those diseases for the first two or three months of its life, the most critical period of its life. However during this same period the maternally derived antibodies can block the effects of vaccination of the pup. This blocking effect decreases as the maternal antibody gradually disappears over those two to three months. A point in time is reached when vaccination can be

successfully given. Unfortunately this point varies between pups, mainly because the amount of maternal antibodies that each pup receives is variable. This is part of the reason that two vaccinations are usually given, two to four weeks apart, in the puppy vaccination program. Maternal antibody interference has been a particular problem with canine parvovirus vaccination.

Incomplete immune response – There is variation between dogs in their immune system. Some respond less well to vaccination, so immunity may be incomplete or shorter-lived than normal. Certain breeds and genetic lines have a tendency for such problems.

Declining immunity – Without booster vaccinations, or without natural boosting of immunity by sporadic exposure to the infectious agent in nature, immunity to the specific organism declines over time, particularly in older age. There may come a time when if there is a particularly heavy dose of the organism from the environment the declining immunity may be insufficient and overwhelmed, disease resulting.

Immune suppression – Certain infections and some drugs, such as anti-cancer drugs, may cause a suppression of the immune system so that an otherwise well-vaccinated dog becomes susceptible to infection and disease if exposed.

New strains of organism – Some infectious agents exist in different strains or new strains evolve, that are not directly covered by the vaccines given. There may be some ‘cross-protection’ but it may not be complete.

The above are not the only reasons for vaccination “failure” but they are the most likely explanations.

If you feel your dog has contracted an infection for which it has been vaccinated then let your veterinarian know so tests can be undertaken to try and establish why vaccination has failed to be protective.

*This client information sheet is based on material written by Ernest Ward, DVM.
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