FACT SHEET

THE IMMUNE RESPONSE TO VACCINATION

A brief review

This Fact Sheet accompanies the 2013 AAFP Feline Vaccination Advisory Panel Report published in the *Journal of Feline Medicine and Surgery* (2013), Volume 15, pp 785–808.

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The 2013 Report of the Feline Vaccination Advisory Panel of the American Association of Feline Practitioners (AAFP) provides practical recommendations to help clinicians select appropriate vaccination schedules for their feline patients based on risk assessment. The recommendations rely on published data as much as possible, as well as consensus of a multidisciplinary panel of experts in immunology, infectious disease, internal medicine and clinical practice. The Report is endorsed by the International Society of Feline Medicine (ISFM).

The cat's immune system

The cat's immune system prevents or limits infectious diseases with three layers of defense:

- The physical barrier of the skin and mucosal epithelium;
- The innate immune system;
- The adaptive immune system.

Physical barrier

The physical barrier provided by the skin and mucosal epithelium prevents invasion via many mechanisms, including cilia that flush away pathogens and proteins that degrade invading organisms. Once the barrier is breached, all aspects of immunity are highly specific and coordinated.

Innate immune system

The innate immune system includes neutrophils, macrophages, dendritic cells and natural killer cells that prevent many pathogens from infecting and/or causing disease in animals. These cells respond to pathogens by recognizing molecules that are broadly shared by pathogens but are distinct from self-tissue.[1] The innate immune system is the first line of immunological defense and is the arm of the immune response that is activated by adjuvants in vaccines. Activation of this innate system is required for effective vaccination.[2] Some commonly used adjuvants include bacterial products added to vaccine preparations, as well as modified-live viruses and vaccine vectors such as canarypox. So-called 'adjuvant-free' vaccines provide innate immune activation via the vaccine vector or modified-live virus itself as they are recognized as foreign by the innate immune system.

Adaptive immune system

Acquired immunity is characterized by pathogen specificity and memory. It is stimulated when an animal is vaccinated or exposed to an infectious agent or antigen. The acquired immune system consists of humoral immunity and cell-mediated immunity (CMI). In humoral immunity, differentiated B lymphocytes, called plasma cells, produce the primary feline immunoglobulin classes IgG, IgM, IgA and IgE.[3] CMI comprises T lymphocytes, including T helper, T regulatory and T cytotoxic cells, which all contribute to vaccinal immunity.[4]

When an animal is infected or vaccinated, B and T lymphocytes specific for a multitude of antigenic epitopes on viruses, bacteria and/or parasites are stimulated to proliferate and differentiate into effector and memory cells. Effector cells are short lived (days to weeks), whereas memory B and T cells provide long term immunity and are able to differentiate into effector cells during subsequent challenge with the same pathogen. Memory cells are not maintained by constant exposure to their specific pathogen but, rather, by non-specific activation (eg, commensal bacteria or environmental irritants) that induces low-level cellular proliferation. Memory B and T cells cooperate to provide protection from infection at a later time in the life of the vaccinated animal. Immunologic memory is the basis for protective vaccines.[5] CMI and humoral immunity are stimulated within minutes to hours when a vaccinated animal is exposed to an infectious agent (anamnestic response), whereas it often takes days to weeks (primary response) for immunity to be stimulated in a non-vaccinated, immunologically naive cat.[4,6–9]

Whether cell-mediated or humoral responses are most important for mediation of protection varies with the specific pathogen, the route of infection, and the colonization and replication of the infectious agent. For instance, many pathogens of the respiratory or gastrointestinal tract require generation of mucosal cellular and/or humoral immune responses, with IgA being the most effective and abundant antibody class on the mucosal surfaces of the cat.[10] As such, mucosal immunization is a highly effective means of inducing long-lasting antigen-specific IgA and mucosal CMI.[11] Systemic infections are controlled or prevented primarily by IgG and circulating effector T cells.[2]

If vaccination prevents subsequent infection, the animal is considered to have sterilizing immunity, the ultimate form of immunity since disease cannot develop. This form of immunity may occur after immunization against feline panleukopenia virus and rabies virus.[12,13] When vaccination does not prevent infection (eg, feline herpesvirus-1 and feline calicivirus),[6] systemic and local CMI, along with humoral immunity including local IgA antibodies, provide protective, but non-sterilizing immunity that only reduces the severity of disease.[4]

Immunocompromise and immunosenescence

While only limited feline-specific data exist,[12,14–18] we know collectively from other species that, with age, the immune system undergoes profound changes resulting in an overall decline in immune function known as immunosenescence. There is no single cell type or organ responsible for immunosenescence. Rather, in a system reliant on absolute coordination of all parts to function effectively, there is a loss of multiple levels of control, including the barrier, innate and adaptive arms of the immune system. Age-related declines in immune function directly translate into increased susceptibility of aged patients to infection, autoimmune disease and cancer. Memory responses to vaccine antigens in aged patients, while less robust than in young adults, appear to be sufficient enough to maintain protective levels of antigen-specific antibody in the majority of cases.[19] If a cat is routinely immunized through its adult years then maintaining vaccination protocols at recommended intervals is warranted in senior cats. Intervals do not need to be decreased because titers are likely to be maintained between boosts; however, intervals should not be increased either due to immunoscenescence.[17,18,20]

One of our greatest gaps in knowledge is what immunization schedule to recommend for aged cats with an unknown vaccination history or that are receiving their first doses.[16] At the current time, two to three immunizations given at 3–4 week intervals are likely to establish sufficient protection against the core vaccine antigens. When other vaccines are deemed necessary, a parallel situation could be drawn from human geriatric patients immunized yearly against new strains of influenza virus.[21,22] These studies suggest that while immunization with new antigens is not as effective in the elderly as it is in healthy adults, it is beneficial at reducing the deleterious effects of infectious disease.

Immunocompromised patients

Cats presumed to have an impaired immune response are not uncommon. In particular, cats infected with feline immunodeficiency virus or feline leukemia virus or those receiving ongoing immunosuppressive therapies, are at an increased risk of infection. Although data is limited, immunosuppression with retroviral infections has been associated with development of clinical disease following the use of live vaccines. In the face of immunosuppression, killed vaccines may theoretically be preferable. Because immune responses can be hampered, vaccination should be updated before immunosuppressive therapies are started wherever possible.

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DISEASE INFORMATION FACT SHEETS
- Feline herpesvirus 1
- Feline calicivirus
- Feline panleukopenia
- Rabies
- Feline leukemia virus
- Feline immunodeficiency virus
- Feline infectious peritonitis
- *Chlamydophila felis*
- *Bordetella bronchiseptica*

SUPPLEMENTARY FILES
Fact Sheets accompanying the 2013 AAFP Feline Vaccination Advisory Panel Report are available, together with the Pet Owner Guide included in Appendix 2, at
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GENERAL INFORMATION FACT SHEET
- The immune response to vaccination: a brief review

PET OWNER GUIDE (APPENDIX 2, pp 807–808)
- Vaccinations for Your Cat