DISEASE PREVENTION IN DOGS AND CATS BY USE OF VACCINES AND OTHER PREVENTIVE MEASURES

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- There are many risk variables to take into account when assessing an animal in need of vaccinations.

- There are 2 basic halves of the immune system
  - **Innate**
    - More primitive but essential
  - **Adaptive**
    - This is the one that responds to vaccines

- When an infectious organism enters the body, the innate system responds first, followed by the adaptive system a few days later.

- **Vaccination**
  - The process by which exposure to a harmless form of an infectious agent (an "attenuated" or "killed" form of the agent) leads to generation of an adaptive immune response and generation of a memory immune response.

  - The purpose of vaccination, as currently practiced, is **to protect individual animals** and **populations** of animals from lethal or disease-producing infections.

- There are **genetic influences** that affect the immune response to vaccines.

- **Maternal antibodies (MDA)** can affect or block the response to vaccines.

- Only when MDA levels are low enough can puppies/kittens respond to vaccines.

- There are variable levels of MDA between litters, and even between littermates.

- Vaccination schedules take into account the varying levels of MDA and how long they can last.

- At or **after 4 weeks of age** it is safe to give the **CORE** vaccines.

- Unless puppies or kittens are **colostrum-deprived and/or they are in a high risk environment** it is not recommended to start the vaccination program for pet animals before **6 weeks** of age.

- **Overall Objectives of Vaccination**
  - Vaccinate puppies/kittens on a schedule designed to minimize the effects of maternal antibody interference
  - To vaccinate each animal only against infectious agents to which it has a realistic risk of exposure
  - To vaccinate against infectious agents that cause significant disease

- To vaccinate an animal only when the potential benefits outweigh the potential risks
- To vaccinate each animal no more frequently than necessary
- To vaccinate the greatest number of animals possible in the population at risk
  - When the population level of immunity "herd immunity" falls below about 65%, there is a risk of outbreaks of that infectious disease.
- To vaccinate appropriately to protect human/public health
- Vaccinate before exposure to infectious disease

- **Infectious vaccines (modified live vaccines "MLV", live attenuated vaccines)**
  - Must infect the animal to cause an immune response
  - Are a weakened strain (attenuated)
  - Stimulate all aspects of acquired immunity
  - Often the most effective type of vaccines
  - Induce the **longest duration of immunity (DOI)**
    - Often years to a lifetime
  - Can often only require one dose to immunize once MDA gone

- **DNA vaccines (Naked DNA vaccines, Genetic vaccines, Recombinant DNA vaccines, Viral vectored recombinant vaccines)**
  - Most like the infectious vaccines
  - Protein antigens they encode or contain can be expressed by antigen presenting cells
  - Induce all forms of acquired immunity
  - Don't cause the actual disease

- **Noninfectious vaccines (Inactivated, Dead, killed, idiotypic, peptide, subunit, synthetic, toxoid, antivenom or bacterins)**
  - Cannot infect and multiply
  - Must contain an adequate amount of antigen to stimulate an immune response.
  - Often contain an adjuvant
    - A substance that non-specifically enhances the immune response.
  - Require multiple doses to immunize
  - Provide a shorter DOI than infectious vaccines
  - Stimulate primarily systemic humoral immunity, limited cell-mediated immunity and little or no mucosal immunity
  - Suggested to be more likely to cause an immunological adverse reaction

- **Booster intervals for noninfectious vaccines**
  - When the interval between the initial two doses of a noninfectious vaccine **exceeds 6 weeks**, it is recommended the dog/cat be revaccinated, administering two doses, 2–4 week apart, to ensure protective immunity has developed.
  - If they do not receive the second booster in time, they are not considered to be protected.
  - With most **noninfectious vaccines**, the minimum time from administration of the first dose in the initial vaccination series to development of protective immunity in a naïve dog/cat is 3 weeks
    - 2 week minimum interval between doses plus 1 week for antibody production, for a minimum of 3 weeks

- Vaccine expectations vary
  - **Sterilizing immunity** (will not get sick when exposed to the disease)
  - **Non-sterilizing immunity** (minimize disease symptoms)
  - **Route of administration** differences
    - Intranasal vs. injectable (parenteral)

- Vaccines are divided into 2 categories:
  - **CORE**
    - Essential for everyone
  - **NONCORE**
    - "Life-style" vaccines

- **Core diseases** for dogs
  - Rabies
  - Canine distemper (CDV)
  - Canine adenovirus (CAV-1, CAV-2)
  - Canine parvovirus (CPV)

- **Noncore diseases** for dogs
  - Parainfluenza
  - Bordetella
  - Leptospirosis
  - Lyme
  - Canine influenza (H3N8 and H3N2)
  - Coronavirus
  - Crotalis Atrox

- **Rabies** booster schedule for dogs and cats
  - Can give at 12 weeks of age or older
  - Booster 1 year later, **no matter what age the first dose was given.**
  - Then booster every 1-3 years
    - Vaccine type and local/state regulations will dictate this interval
  - Titers are not a legal substitute at this time
  - An animal is not considered immunized until 28 days after the first rabies vaccine has been given.

- **DA2P/DA2PP** booster schedule
  - **Puppies**
    - Start at 6-8 weeks of age
      - Earlier for some per previously discussed reasons
    - Use **MLV combo** or **rCDV + MLV combo's**
    - One dose of these can prime and boost when MDA's are gone
    - Booster every 2-4 weeks
    - End at ≥ 16 weeks of age
      - 18-20 weeks in high risk areas

        - Booster a year later, then every 3 years or run annual titers as adults
        - Boostering an already well-vaccinated bitch prior to pregnancy does not increase her level of antibody being transferred to her puppies

    - **Adults**
        - **Option 1***
            - Initial series of 2
            - Booster 1 year later
            - Then booster every 3 years or perform annual titers
        - **Option 2**
            - Give 1 dose of a Modified Live Vaccine (MLV) or Recombinant vaccine
            - Booster in 1 year
            - Then booster every 3 years or perform annual titers
        - Either protocol is considered acceptable

- Use of **TITERS** in lieu of vaccination

    - Applies to only certain diseases
    - Must meet 2 criteria:
        - Must have a **measurable blood antibody** level
        - Paired with challenge studies
        - Expose animal to disease and see if it gets sick or not when at a specific titer level
    - Dogs (DA2P)
        - Canine distemper
        - Canine parvovirus
        - Adenovirus
    - Cats(FVRCP)
        - Panleukopenia (Feline distemper)
        - Calicivirus
        - Rhinotracheitis
    - Rabies (generally not allowable)

- **Noncore vaccines** for dogs

    - **Leptospirosis**
        - 2 and 4 serovar vaccines available
            - Pomona, Icterohaemorrhagiae, Grippotyphosa, Canicola
        - Start ≥ 9 weeks of age per label
            - ≥ 12 weeks recommended by many immunologists
        - Booster in 3-4 weeks and then annually
        - Restart series if > 6 weeks overdue for second booster of series
        - Restart series if > 18 mo. since last annual booster
        - Single dose is not effective if do not complete booster series

    - **Lyme**
        - Start ≥ 9 weeks of age per label
            - ≥ 12 weeks recommended by many immunologists
        - Booster in 3-4 weeks
            - Restart series if > 6 weeks overdue for second booster of series
        - Repeat annually

- Restart series if > 18 mo. since last annual booster
- Single dose not effective
- Best to finish series prior to tick exposure

- **Bordetella**
  - Parenteral (Injection under the skin)
    - Series of 2 if no previous Bordetella vaccination
    - Start at 8 weeks of age
    - **Do NOT give orally**
  - Intranasal vaccine **(Don't inject parentally!)**
    - Can start at 3-4 weeks of age
    - Single dose
    - Bordetella only and combo vaccines
    - **Do NOT give orally**
  - Oral vaccine **(Don't inject parentally!)**
    - Bordetella only
    - ≥ 8 weeks of age
    - Single dose
  - Booster all forms every 6-12 months.

- **Parainfluenza**
  - Intranasal vs. parenteral
  - Often combined with DA2P
    - Called DA2PP
    - Booster with same schedule as DA2PP
  - Often combined with Bordetella
    - Booster per Bordetella schedule
  - If using DA2P only
    - Give CPiV with a Bordetella combo vaccine

- **Crotalis atrox**
  - 4 months of age or older
  - It works by producing antibodies against the venom, which are effective for about 6 months in most dogs
  - Initial series of 2 separated by 1 month, then every 6-12 months
  - Max protection 4-6 weeks after most recent booster
  - Dogs < 25# and >100#, or increased risk of frequent exposure, are recommended to have additional boosters.
  - Western Diamondback
    - Some efficacy? (Western Rattlesnakes (including the Prairie, Great Basin, Northern and Southern Pacific varieties), Sidewinder, Timber Rattlesnake, Massasauga and the Copperhead)
  - No protection: Water Moccasin (Cottonmouth), Mojave Rattlesnake or Coral Snake.
  - Bitten dogs still need treatment!

- **Canine influenza (H3N8 and H3N2)**
  - ≥6 weeks of age
  - Booster in 3-4 weeks then annually
    - Restart series if >6 weeks overdue for second booster
    - One dose of the series does not protect

        - Restart series if > 18 months since annual booster
        - No cross protection between strains
        - Bivalent* and individual strain vaccines available
    - **Coronavirus**
        - Often combined with DA2PP vaccines
        - **Not recommended** by AAHA
            - Self-limiting in most dogs
            - Very young puppies (<6 weeks) affected the most
                - Too young to vaccinate
        - Not effective at minimizing disease

- **Feline-specific vaccine concerns**

    - **Vaccine Associated Sarcoma (VAS)** or **Feline Injection Site Sarcoma (FISS)**
        - Very bad
        - Difficult to remove
        - 1:10,000
        - Seen world-wide
        - Exact cause is not known, but inflammation appears to play a big role
    - Adjuvant vs. nonadjuvant vaccines
        - Adjuvants cause more inflammation
    - Vaccine locations
        - **RF**: At or below elbow: **FVRCP**
        - **RH**: At or below stifle (knee): **Rabies**
        - **LH**: At or below stifle (knee): **FeLV**
        - Towards end of **tail** if high risk or already missing a leg

- KSU VHC tends to use **non-adjuvant** vaccine or **intranasal routes** when possible in cats.

- **FVRCP** vaccine types

    - **Parenteral (injection)**
        - ***MLV***
            - Adjuvant
            - Nonadjuvant
            - Fastest protection against Panleukopenia
        - ***Killed***
            - Adjuvant
        - ***Ultra Hybrid 0.5 ml vaccine***
            - Nonadjuvant, killed calicivirus (2 strains)
            - MLV panleukopenia and rhinotracheitis
    - **Intranasal**
        - ***MLV***
            - Fastest protection against Upper Respiratory Infection
            - Don't use if already have URI

- **Feline Core Vaccines**
    - Rabies
    - Panleukopenia (aka. feline parvo, feline distemper)
    - Rhinotracheitis (aka. herpes)
    - Calicivirus

- **Feline Noncore Vaccines**
    - FeLV
    - FIV
    - FIP
    - Bordetella
    - Chlamydia

- **FVRCP vaccine schedule**
    - **Kittens**
        - Start 6-8 weeks of age
        - Booster every 3-4 weeks
        - End at 16-20 weeks of age
        - Booster 1 year later
        - Then every 3 years (FPV) thereafter or run annual titers
            - The respiratory viruses may require more frequent boosters in some cases depending upon life-style
    - **Adults**
        - Two doses of the respiratory components of the vaccine are recommended even if > 16 weeks of age, regardless if it is a MLV.

- **Additional FVRCP information**
    - Many laboratories offer titers for all 3 of these viruses, but only FPV titer is reliable for prediction of protection
    - MLV parenteral product for a cat/kitten's first vaccine will get the fasted protection against panleukopenia, so typically use this for the first vaccination
    - If a MLV core vaccine that must be given systemically (by injection) is given locally (e.g.intranasally or conjunctivally), the vaccine may cause disease.
    - Injection goes **right front leg at or below the elbow**

- **FELV** vaccine schedule
    - Parenteral only
    - Most have adjuvant and one nonadjuvant
    - Start 8 weeks of age
    - Booster in 3-4 weeks, then 1 year later
    - Annually (high risk) or biannually (low risk) thereafter

- Restart series if > 6 weeks between series boosters
- Recommended for ALL kittens as they are most susceptible to the disease
- Testing prior to vaccination recommended
- Low **left hind leg**

- **FIV**
  - Controversial vaccine for several reasons
  - Strains don't cross protect
  - Was discontinued in the U.S. as of June 2016
  - Interferes with test potentially for several years

- **Bordetella bronchiseptica**
  - Intranasal
  - ≥8 weeks of age
  - Single dose
  - Annual revaccination
  - Efficacy?
  - Per the AAFP, "The benefit of vaccination in shelter-housed cats against this disease agent is limited. The association between B. bronchiseptica isolation and disease in shelters is inconsistent"
  - **Not recommended unless** "cats will have direct or indirect contact with dogs that have a recent or current history of respiratory disease caused by this agent".

- **Chlamydia**
  - Start at 9 weeks of age
  - Booster in 3-4 weeks
  - Annual revaccination
    - Thoughts that protection may not last an entire year
  - Contains adjuvant
  - **Not recommended for the general population**
  - Only recommended in "those situations where this disease has been the documented as the cause of the problem."

- **FIP**
  - AAFP
    - "At this time, there is insufficient evidence that the vaccine induces clinically relevant protection, and use of the vaccine is "**Not Recommended**".

- **Important TTD for breeders**

  - It is very important that the breeder document information, preferably veterinary records, of what vaccines, dewormings, etc. the puppy/kitten has received.
  - Copies of the records should be given to the new owner so that they can be shared with their veterinarian.
    - This will ensure that the series of vaccinations continues and that the vaccination program is adequate to provide the protection required.

- **VACCINE REACTIONS (aka. Adverse Events) STATISTICS**

  - Reactions occurring within 3 days of vaccination in 1.2 million **dogs** receiving 3.4 million doses of vaccine (some dogs receiving multiple doses during their puppy program).
    - **Any type** of documented reaction was 38 dogs per 10,000
    - Majority of these reactions were mild and of no clinical consequence.

  - Reactions occurring within 30 days of vaccinating 496,000 **cats** with 1.2 million doses of vaccine.
    - 51 per 10,000 cats vaccinated
    - Over half of these reactions were simply mild lethargy and fever

  - Adverse reactions based on these 2 studies are mostly mild and are relatively uncommon
    - Around 38–51 events per 10,000 vaccinations
    - = 0.38% to 0.51%

- **Adverse events**

  - Because most adverse reactions are genetically controlled, certain dog breeds (especially some of the small breed dogs) and certain families of dogs and cats are more likely to develop adverse reactions than animals in the general population
    - **It is critically important for dog and cat breeders to record any adverse events believed to have occurred as a result of vaccination in their dogs and cats.**

  - When a given mating is known to produce offspring that have a high percentage of adverse reactions to certain vaccines...
    - Would be desirable to neuter either or both of the parent
    - Ensure the same two dogs are not mated again

  - Some **small breed dogs** have a greater likelihood of developing immediate hypersensitivity reactions after vaccination than do many of the large breed dogs

    - It has been suggested that the **killed bacterial vaccines (bacterins)** like Leptospira, Bordetella, Borrelia or the killed adjuvanted viral vaccines like rabies virus vaccines may be more likely to trigger an immediate hypersensitivity reaction than are the MLV vaccines

    - **DO NOT** use a split-dose of vaccine to these animals.
      - Vaccines are formulated with a specific immunizing dose and need the entire dose.
      - Unless the entire content of the vaccine vial is administered, the dog may fail to make a protective immune response.

    - One may wish to **delay** administration of **inactivated noncore vaccines** to small breed dogs until after completion of the initial core vaccine series.

  - **Adoption of the current vaccination guidelines** as discussed will minimize the risk of adverse reactions occurring in your pet following vaccination.

    - **Consult with your veterinarian** about...

- Core and use of non-core products
- Frequency of administration
- Avoidance of adjuvanted products (where possible)

- **Simply not vaccinating is not an option!**
  - The risks of contracting life-threatening infectious disease remains potentially high, even in developed countries.

- **In the event of an adverse vaccine event…**
  - **Notify your…**
    - Veterinarian
    - Manufacturer
  - **Note in the health record**
    - Keep a log (sticker) of vaccine, serial number, etc.
    - Route and site of administration
    - Type of reaction
    - Time between vaccine and reaction
    - Other vaccines administered
    - Previous vaccine history
    - If others in the litter affected
    - Treatment

- **Other important vaccination tidbits**

  - **Pregnant animals**
    - Wherever possible **vaccines should not be given during pregnancy** as some could cause problems (e.g. stillbirths, abortions, weak offspring, developmental abnormalities)
    - The exception to this would be where a vaccine is specifically licensed for use during pregnancy
    - When necessary, vaccination should ideally be **prior to or after** pregnancy.

  - **Non-responders**

    - **Unable to develop antibody** to the virus, regardless of how often they are vaccinated.
      - **Often die** from the disease if infected
    - General population
      - **CPV-2** is 1 per 1,000 dogs
      - **CDV** is 1 per 5,000 dogs
    - Numbers can be higher in a specific breed or family of dogs
    - Non-responders to CAV-1 or CAV-2 have not been found
    - Estimated that only **1 in 50,000–100,000 or more dogs**
    - Don't know the percentage of non-responders to **rabies** virus, but they do exist.

  - **Can vaccine be administered weekly to puppies (and kittens) that may be at high risk of exposure to an infectious pathogen? (AAHA)**
    - *Ideally, vaccines should not be given more often than every 2 wk, **even if different vaccines are administered**. Transient down regulation of the immune system after administration may interfere with subsequent vaccine administration for up to 10 days. However, in certain situations (short-term stay in shelters), it may be necessary to vaccinate at intervals of < 2 wk.*

- **For how long can a reconstituted MLV vaccine remain at room temperature without losing activity? (AAHA)**
  - *At room temperature (e.g., 60–80°F), some of the more sensitive MLV vaccines (e.g., CDV) may lose their ability to immunize after 2–3 hr. It is recommended that MLV vaccines be discarded if kept at room temperature for ≥1 hr. after reconstitution.*

  - **Beware of buying vaccine where you do not know how it was handled and/or stored**

- **Additional methods to control/prevent infection of diseases**

  - VACCINATIONS ALONE **ARE NOT A GOOD SUBSTITUTE** FOR POOR HUSBANDRY PRACTICES!!!

  - **Isolate** sick animals immediately
  - Healthy animals should be taken care of **prior to** handling sick animals
  - Young animals should be handled **before** adult animals
  - Animals with diseases spread via contact with feces should have their **waste removed and disposed of immediately**.
  - Disinfection of surfaces and inanimate objects contaminated with feces or urine should occur using products approved for disinfection of the **suspected** virus or bacteria.
  - **Gross removal of waste** product should be done first and then the disinfectant applied for the designated amount of time.
  - **Dilute bleach (1:10)** is a good disinfectant for almost all diseases.
  - Animals with **respiratory diseases** should be isolated in a separate room. Tables, floors and other inanimate objects should be disinfected.
  - Puppies **should not** be allowed to go to dog parks, pet stores or other places where dogs of unknown vaccine status may be until they are at least **2-3 weeks past the last DA2P** of their series.
  - Puppies **can attend puppy classes 1 week after the first DA2P** has been given if the class requires all puppies to be up to date on their vaccines.
  - **Keep cats indoors**. Kittens/cats should not be allowed outdoors (if allowed) until they have completed their core and FeLV vaccine series.
  - Dogs being boarded or participating in activities where they will be around other dogs should have their **Bordetella** vaccine given (or the series of 2 finished) at least 2 weeks prior to boarding or the event. They should then be boostered every 6-12 months.
  - Dogs and cats bitten by a known or suspected rabid animal should have their **rabies vaccine** boostered within **96 hours** of the incident.
  - Testing and culling for diseases such as FIP, FIV and FeLV should be done by catteries to minimize the spread of these diseases.
  - In shelters/breeders, new arrivals should be quarantined for a minimum of 2 weeks
  - In **infected breeding catteries**, queens should kitten in isolation and the litter should not mix with other cats until vaccinated
  - Do not allow sick animals to interact with other animals until the **shedding time for the disease is over**.
    - This can be anywhere from a few days to several weeks.
  - Use good **flea/tick control year-round** on pets.
  - **Don't** encourage wildlife to hang around **by feeding them**.
  - Avoid taking pets to areas that currently have a known outbreak of a particular disease.
  - Keep your pet **current** on its necessary **vaccines**

- **Conclusions**
  - **Many fatal diseases are easily preventable** if the animal is vaccinated against them.
  - Vaccination **schedules should be tailored** to meet the individual needs of each animal.
  - New products, new diseases, etc. will cause **ever-evolving guidelines.**
  - If animals do become ill, **appropriate isolation and disinfection methods** should be employed.

  - ***Breeders play a large part in ensuring their animals are healthy and providing the necessary information to new owners to aid in the continuation of good health in the animals they raise and sell!!!***

Resources

- American Association of Feline Practitioners (AAFP) 2013 vaccine guidelines
- American Animal Hospital Association (AAHA) 2017 vaccine guidelines
- World Small Animal Veterinary Association (WSAVA) 2015 vaccination guidelines for the owners and breeders of dogs and cats
- www.rabiesaware.org

Table 1
Adverse Reactions Associated with Vaccination in Animals

Severe Reactions (Rare to Very Rare)	Moderate Reactions (Uncommon to Rare)	Mild Reactions (Uncommon)
Injection site sarcoma	Immunosuppression	Lethargy
Anaphylaxis	Behavioural changes	Hair Loss
Polyarthritis, hypertrophic osteodystrophy (HOD)	Vitiligo	Hair colour change at injection site
Immune-mediated haemolytic anaemia (IMHA)	Weight loss	Fever
Immune-mediated thrombocytopenia (IMTP)	Reduced milk production	Soreness
Glomerulonephritis	Lameness	Stiffness
Disease or enhanced disease for the vaccine was designed to prevent	Granulomas/abscesses at the injection site	Refusal to eat (transient)
Myocarditis	Hives	Conjunctivitis
Post-vaccinal encephalitis or polyneuritis	Facial oedema	Sneezing
Seizures	Atopy	Coughing
Abortion, congenital anomalies, embryonic/fetal death, failure to conceive	Respiratory disease	Oral ulcers
	Allergic uveitis (blue eye)	Diarrhoea
	Skin disorders	Vomiting

Common reactions: >1 but <10 per 100 animals; uncommon reactions: >1 but <10 per 1,000 animals; rare reactions: >1 but <10 per 10,000 animals; very rare: <1 per 10,000 animals

WSAVA vaccine guidelines