Chapter 59

Vaccine: The Savior in Cats

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ABSTRACT

Cats are one of the most common pets but prone to several diseases and parasites. There are solutions to keep the cat safe from these illnesses like vaccines and role of veterinarian in management of diseases. This chapter emphasizes the role of vaccine to prevent these diseases in cats. It describes the different types of vaccines like live vaccine, attenuated vaccine, and subunit ones. It discusses vaccine schedule and core and non-core vaccines for cats. The manufacturing and the material used in manufacturing process is also presented. The efficacy of different types of vaccines, duration of immunity they provide and recommendation regarding their use is also discussed.

KEYWORDS
Felis Catus, Cat diseases, Vaccines and types, Duration of immunity, Vaccines efficacy

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INTRODUCTION

The domestic cat (*Felis catus*), also called the housecat, and is a little carnivorous animal that people cherished for its hunting ability and company. Cats are the most popular pets worldwide and have been associated with humans for about 9,500 years. Their close association with humans has led to their presence almost everywhere on Earth, causing concerns as an invasive species due to their impact on native animals (Brown, 2020). Feral cat populations, reaching up to 60 million in the US alone, contribute to these issues. Cats share similarities in anatomy and size with further felids, equipped through agile figures and specialized teeth for hunting. They are skilled predators, relying on keen senses for hunting. Cats are gregarious animals even though they are solitary hunters, using various vocalizations, scents, and gestures that convey information, such purring, hissing, and meowing. Some are bred and exhibited as pedigreed pets, a hobby known as cat fancy (Robbins, 2012).

Cats can withstand high temperatures better than humans. Their discomfort typically sets in when their skin reaches about 52 °C (126 °F), but with access to water, they can endure temperatures up to 56 °C (133 °F) without significant discomfort. They stay warm by reducing blood flow to their skin and cool down by panting and vaporization through their mouth. Cats don't perspire and rarely gasp except in extreme heat. Unlike humans, their body temperature remains constant throughout the day due to their lack of circadian rhythms. Their dry feces and concentrated urine help them retain fluids, and their efficient kidneys allow them to survive on a meat-only diet and even drink seawater to replenish (Eldredge et al., 2008).

Cats can get sick with lots of different problems, like infections, bugs, injuries, and long-lasting sickness. In modern preventive veterinary medicine, vaccination is vital for controlling common infectious diseases in cats. Passive immunization involves administering preformed antibodies to animals, serving as an alternative to maternal immunity. This method is particularly useful for colostrum-deprived neonates, unvaccinated high-risk puppies and kittens, and immunocompromised animals. Active immunization, achieved through various vaccine types like modified live, inactivated, and subunit vaccines, is also crucial. Understanding the unique features of these vaccines and potential causes of vaccination failures is essential for implementing successful vaccination schedules in small animal practice (Para et al., 2022).

Vaccination is a well-established idea in preventative medicine and a significant revenue stream for the majority of veterinary clinics. Vaccines administration is a daily task for the majority of veterinary surgeons, but it has become so automatic that few ever pause to think about the science underlying this area of veterinary medicine. Both the medical and veterinary communities highlighted potential side effects of vaccination in the late 1990s.

According to international vaccination guidelines from organizations like World Small Animal Veterinary Association, Advisory Board on Cat Diseases - ABCD, The American Association of Feline Practitioners – AAFP, every feline should receive immunization against specific prevalent illnesses such as *Feline parvovirus* (FPV), *Feline calicivirus* (FCV), and *Herpesvirus-1* (FHV-1), no matter where they live (Larson Rabies vaccination is also important, especially in areas where

rabies is common (Larson and Schuitz, 2021). Additional vaccines may be recommended based on a cat's lifestyle and where they live. In Italy, core vaccinations include those against *Parvovirus*, *Feline calicivirus*, and *Herpesvirus-1*, with rabies vaccination required only for travel outside the country. Inoculation against *Feline Leukemia* (FeLV) is also advised for kittens and adult cats at heightened risk. The vaccination for feline infectious peritonitis is typically not endorsed.

Vaccinating dogs and cats has raised concerns among vets and pet owners due to worries about safety and how long the immunity lasts. New evidence suggests, we might be vaccinating too often for some diseases, and there can be rare but serious problems linked to vaccination. There are also questions about how well vaccines work and if it's necessary to use all available vaccines on every animal. Various individuals and groups are suggesting changes to current vaccination practices. The Canadian Veterinary Medical Association has recently released a strategy to address vaccine procedures, including a Public Announcement regarding Vaccinations (Carpenter et al., 2022).

Vaccine Design

Viruses, bacteria, fungus, protozoa, or helminths can all be used to make vaccines. Manufacturers produce vaccines through either attenuating ("modified live virus (MLV)") by serial passage over culture or inactivating ("killed") methods. Animals infected with attenuated products have restricted replication and humoral, cell-mediated, and mucosal immunity. Such vaccines typically penetrate maternally derived immunity at a younger age than inactivated products and prompt immunity more swiftly than the latter. Moreover, they elicit protective immunity after just one dose (provided maternal immunity has diminished). Due to being living organisms, attenuated products may become deactivated due to incorrect storage or administration. A less common yet more significant concern is the possibility that these vaccines may not be sufficiently weakened, potentially resulting in disease onset (Alamgir and Alamgir, 2018).

There are only inactivated treatments available for some diseases, such as the *Feline leukaemia virus* (FeLV), *Leptospira spp*., *Borrelia spp*., and rabies virus. However, only weakened products are available for diseases such as the measles virus, canine adenoviruses 1 and 2, feline coronavirus, canine distemper virus, and parainfluenza virus. Certain diseases, including *Feline calicivirus*, *Canine coronavirus*, *Canine parvovirus*, *Bordetella species*, *Herpesvirus*, and *Chlamydia psittaci*, can be treated with any of the two product variants (Baneth, 2020). Numerous vaccines incorporate antigens from various pathogens for convenience, yet regulatory agencies overseeing product licensing mandate that these multi-antigen products demonstrate equivalent efficacy to vaccines containing singular antigens. Nonetheless, there is evidence indicating that in certain instances, multiple antigens might disrupt the immune response to the vaccine. Conversely, some argue that using combination vaccines in cats may reduce the risk of post-vaccinal sarcomas by administering less adjuvant. These problems are yet unresolved.

Diluents include water for suspension, indicator colors, buffers and preservatives are used in vaccines. These diluents are specifically intended for each vaccine product, thus they should not be mixed with diluents from different vaccine brands. Emerging vaccine technologies strive to improve safety, incorporating "isolated" Bactrians (Without bacterial endotoxin and made up only of bacterial surface antigens) and "subunit" products, for instance a FeLV vaccine having disassembled FeLV virus derived from transformed cell lines. Recombinant DNA technology is also used, where genes encoding protective antigens are cloned and expressed in Escherichia coli to produce non-pathogenic, high antigen concentration products (Hansson et al., 2000). Yet, it remains uncertain whether exposing isolated antigens to the immune system is equally efficient in triggering protective immunity as presenting antigens within the framework of the infectious agent, a factor that may differ depending on the pathogen. Another method using recombinant DNA entails removing virulence genes from the pathogen while preserving protective antigens. Although not yet available for dogs and cats, human hepatitis B virus, swine pseudorabies, and viral vaccines have been authorized using this method. Another strategy is the "vectored" vaccination, where genes encoding protective antigens are inserted into an unrelated virus serving as a delivery system (Trovato and De Berardinis, 2015). For instance, Canada will soon have access to a canine distemper virus vaccination vectored by canary pox. Despite the fact that recombinant vaccinations are probably safe and may not require adjuvants, their effectiveness compared to traditional vaccines remains to be demonstrated (Kruth and Ellis, 1998).

The Efficacy of Vaccination

Challenge experiments have yielded minimal evidence, but vaccinations against canine distemper and pan leukopenia seem to protect most animals for an extended period of time. Nevertheless, certain weakened inoculations used previously underperformed as a result of the vaccination strains' extreme weakness. Such as, it was found that numerous canine parvovirus vaccines didn't trigger protective immunity due to excessive weakening and insufficient antigen content. This issue has been addressed with the development of parvovirus vaccines with lower passage (less weakened) and higher antigen content. Pathogens linked with chronic or latent infections are typically harder to vaccinate against compared to those causing severe infections. The nature of feline herpesvirus, feline calicivirus, and FeLV infections makes vaccination less effective compared to diseases like canine distemper and pan leukopenia. Relying solely on vaccination might not be sufficient to control these types of pathogens, and it's essential to emphasize proper animal care for those at high possibility of such infections (Larson and Schultz, 2021).

Duration of Immunity

The length of time that vaccines protect animals can vary, both depending on the disease and among individual animals vaccinated against the same disease. Sometimes, vaccine protection doesn't last for the entire life of the animal.

Because of this, manufacturers recommend getting revaccinated. Since we don't know how long most vaccines protect for, it's typically recommended to get revaccinated every year, assuming that vaccines are safe. However, there's a concern that vaccination might not always be safe for certain animals. This means that the chances of vaccine-related problems might be lower if cats were vaccinated less often. The yearly schedule for revaccination is a convenient suggestion, but it's not based on studies determining the longest time vaccines protect animals from disease. Some studies have been done to find out the shortest time a vaccine provides immunity, showing that certain vaccines protect for a minimum of a year. Veterinarians understand that the plain way dogs' and cats' immune systems work is probably not very different from humans', who don't need yearly booster shots for many diseases (Gotuzzo et al., 2013). However, the assistances of getting every year check-up along with vaccination have been thought to partly explain this practice in pets. There's now proof that vaccination can sometimes be harmful to certain animals. For instance, some cats develop leiomyosarcoma at vaccination sites, and there's a link between recent vaccination and immune-mediated anemia in dogs. Interestingly, there is now information emerging about how long some vaccines provide protection, especially rabies vaccines. Studies have shown that rabies vaccines can protect for 3 years. One way to measure immunity is by checking the levels of virus-neutralizing antibodies in the blood. For some diseases like canine distemper and pan leukopenia, these antibody levels closely match the level of protection. However, for other diseases like *Feline Herpesvirus* and *Feline Calicivirus*, where protection relies on different parts of the immune system, antibody levels may not accurately show how protected the animal is. Recently, the duration of antibody levels in the blood was studied for *Feline Parvovirus*, *Herpesvirus,* and *Feline Calicivirus*. This study recorded the continuation of antibody levels deemed protective for at least 3 years in all tested cats (Bergmann et al., 2020). Using this information, the American Association of Feline Practitioners and Academy of Feline Medicine have released guidelines suggesting that cats receive initial immunization for feline calicivirus, herpesvirus, and parvovirus, and rabies virus as directed by the manufacturer. Consequently, a booster shot should be administered after 1 year, followed by additional vaccinations every 3 years. The recommendation also says that depending on how they evaluate the risks to their patients, vets may decide to vaccinate more often. Herpesvirus, feline calicivirus, parvovirus, and rabies virus are deemed essential vaccines for entirely felines, considering the widespread prevalence and severity of these infections, or their potential to spread to humans, given the safety and effectiveness of the vaccines. While acknowledging that these recommendations align with available evidence, it's crucial to recognize that they are mostly based on a single trial with a limited number of cats (rabies vaccinations excluded). Only one product was used to vaccinate these cats, thus it might not be representative of other products on the market. Moreover, an experiment publicity test was not conducted. Undoubtedly, this data alone would not be used to approve a new product. "Non-core vaccines" (i.e., only advised for cats with established risk) include *Chlamydia psittaci*, FeLV, and feline coronavirus (Stone et al., 2020). The longest period of protection provided by these vaccines has not been disclosed, and the current suggestion from the American Association of Feline Practitioners is to administer annual booster shots with these products, if the cat is deemed to be at risk of contracting these infections. Similar recommendations have been made for dog vaccinations, wherein the canine distemper virus, adenovirus-2, parvovirus, and rabies virus are considered "essential" vaccinations. These recommendations state that the first vaccination should be administered in accordance with the manufacturer's instructions. The dog must receive a booster shot after 1 year, followed by subsequent vaccinations every 3 years. While this schedule seems biologically reasonable based on serologic evidence, there is limited published data from challenge studies to endorse this timing, except for rabies vaccinations. Parenteral parainfluenza virus vaccines have not been shown to be useful for "non-core" vaccinations (Mitchell and Brownline, 2015). Administering intranasal vaccines containing attenuated *Bordetella bronchiseptica* and parainfluenza virus is recommended for at-risk dogs. However, the duration of immunity provided by these products remains unknown and may last only for months. The *Leptospira* vaccines provide immunity for a short time (months) and don't offer protection against certain serovars like *pomona* and *grippotyphosa*, which are becoming more common. The usefulness of *Borrelia sp*., vaccines is still under debate. It's hard to confirm if canine coronavirus is a significant threat, so the need for vaccination is uncertain. Why not just check serum virus-neutralizing antibody levels and vaccinate when obligatory? As stated earlier, whereas serum levels are good indicators of protection for some diseases, they might not be accurate for others where cell-mediated immunity and mucosal immunity play vital roles. Plus, measuring titers isn't consistent across labs, so results can vary widely. To make titers useful for deciding when to vaccinate, it's important to standardize the tests or have them done by a central lab (Cross et al., 2007).

Below is a quick summary of common feline illnesses and the vaccinations that protect against them:

Feline Pan Leukopenia (FPV)

The feline pan leukopenia (FPV) is a serious, contagious disease that affects a cat's digestive system and immune system. The virus responsible, FPV, belongs to the *Parvovirus*. It spreads through contact with infected feces, including indirect contact through objects like shoes or clothing. Even indoor cats can catch it this way. The kittens are especially vulnerable. The FPV is tough and can endure a long period in the environment, so it's common in many cat populations. In one study, it was found to be the cause of death in 25% of examined kittens. It mainly targets fast-growing cells. In newborn kittens, it can be deadly, causing sudden death or neurological issues like trouble walking or seeing. Older kittens may get sick with symptoms like low white blood cell count and diarrhea. The disease is most often seen in kittens between 2 and 5 months old, while older cats usually have milder symptoms or none at all (Jakel et al., 2012).

Diagnosis

Commercially available test kits detect the presence of feline pan leukopenia virus antigen in feces. Special labs perform PCR tests on either blood or feces. The serological tests are not advised because they can't tell the difference between infection and vaccination.

Disease Management

The supportive care and attentive nursing greatly reduce mortality rates. For enteritis cases, it's advised to administer broad-spectrum antibiotics intravenously. The effective disinfectants include bleach (sodium hypochlorite), per acetic acid, formaldehyde, or sodium hydroxide.

Vaccination Recommendations

All cats, even those that stay indoors, should receive vaccinations. It's typically advised to administer two shots when they're 8-9 weeks old, followed by another shot 3-4 weeks later, and a booster one year later. For kittens from places with a lot of infections, like shelters, or born to vaccinated mothers, another shot at 16-20 weeks old is suggested. After that, boosters ought to be administered at least every three years. The pregnant cats or kittens under 4 weeks old shouldn't get vaccines with live viruses. Vaccines for FPV are typically included in standard vaccinations for cats. They work by triggering the cat's immune system to produce protective antibodies against the virus. These antibodies can be checked to see if the cat is protected (Truyen et al., 2009).

Feline Herpesvirus-1 (FHV-1)

In cats and kittens, feline herpesvirus type 1 (FHV-1) is frequently responsible for ophthalmic and upper respiratory conditions. It may also be a factor in eosinophilic dermatitis.

Hypothesis

Famciclovir (Famvir; Novartis), a systemic anti-herpes medication, is useful in the therapeutic treatment of conditions linked to FHV-1, such as keratitis, conjunctivitis, feline corneal sequestrum, rhinosinusitis, and dermatitis associated with FHV-1.

Clinical Outcome

Vaccines targeting FHV-1 are included in core vaccines for cats. Ten cats with signs of FHV-1, such as eye problems, nose and sinus issues, and skin inflammation, were treated with oral famciclovir. Cats in Australia and Europe took 62.5 mg once or twice a day, while those in the USA were given 125 mg three times a day. The treatment was well tolerated and had a positive impact on all cats. Lesions improved significantly compared to previous treatments, and one cat with severe rhinosinusitis showed marked improvement after a 4-month course. Corneal issues improved in most cats, and oral famciclovir was preferred over topical therapy for convenience. Cats with FHV-1 dermatitis also saw substantial improvement, although some experienced relapse. Overall, famciclovir proved effective in treating FHV-1 symptoms in these cases (Truyen et al., 2009).

Conclusions

Famciclovir seems like a hopeful systemic medication for addressing illnesses linked with FHV-I infection. Further thorough clinical trials are needed to refine the dosage plan for safe and efficient treatment of herpes in feline clinical practice (Malik et al., 2009).

Feline Calicivirus (FCV)

Similar to FHV-1, FCV also frequently causes respiratory infections in cats and causes symptoms including sneezing, nasal discharge, and mouth ulcers. One of the main vaccinations for cats includes an FCV vaccination as well. FCV, or feline calicivirus, is a very unpredictable virus. Recently, more severe, systemic FCV infections have been reported.

Infection

Cats, those with acute infections, or carriers release FCV in secretions from the mouth, nose, and eyes. Infection primarily happens through direct contact.

Disease Signs

The primary symptoms include mouth sores, respiratory issues, and a high body temperature. Feline calicivirus can be found in almost all cats with persistent mouth inflammation or gum inflammation. Cats with 'virulent systemic FCV disease' may exhibit varying signs such as fever, swelling of the skin, sores on the head and legs, and yellowing of the skin. The likelihood of death is high, and the condition is more serious in older cats (Radford et al., 2009).

Diagnosis

Detecting FCV can be done through virus isolation or reverse-transcriptase PCR. Viral RNA can be found in swabs from the mouth and eyes, blood, skin samples, or lung tissue using PCR. Positive PCR results should be approached carefully, as

they might indicate low-level the shedding by cats persistently infected. Diagnosing virulent systemic FCV disease depends on clinical symptoms and identifying the same strain in the blood of multiple sick cats.

Disease Management

It is crucial to provide supportive care (including fluid therapy) and excellent nursing support. Cats that refuse to eat should be given highly appetizing, pureed, or warmed food. Mucolytic medications (such as bromex) or nebulization with saline might provide relief. Administering broad-spectrum antibiotics may help prevent additional bacterial infections. *Feline Calicivirus* can endure in the surroundings for approximately 1 month and is resilient to numerous typical disinfectants.

Vaccination Recommendations

The recommendation is to administer two injections, at 9 and 12 weeks of age, followed by a first booster 1 year later. In situations where the risk is high, it is advised to administer a third vaccination at 16 weeks. Boosters should be administered every 3 years. However, cats facing high risks should receive annual vaccinations. Cats that have recuperated from caliciviral illness likely do not have lifelong protection, especially if infected with varying strains. It is still advisable to vaccinate these cats (Radford et al., 2009).

Feline Leukemia Virus (FeLV)

FeLV is a viral disease that can suppress a cat's immune system, leading to various health problems such as anemia, lymphoma, and secondary infections. Vaccination against FeLV is recommended for cats at risk of exposure, especially those who go outdoors or live in multi-cat households where FeLV-positive cats are present.

Feline Leukemia Virus (FeLV) is a common virus found in domestic cats worldwide. It's grouped into three main subgroups: FeLV-A, -B, and -C, based on their interference and neutralization patterns. FeLV-A is the most widespread, though less harmful. It's easily transmitted but not highly pathogenic. Cats infected with FeLV-A may not show symptoms for a long time, but could eventually develop diseases like lymphoma. FeLV-B and FeLV-C are less common. They develop from FeLV-A within infected cats and can lead to lymphoid malignancies or aplastic anemia, respectively. A newer subgroup, FeLV-T, has been identified, causing immune system issues in infected cats (Hofmann-Lehmann et al., 2007).

FeLV vaccines have been widely used in veterinary practices for years. While some are made from inactivated FeLV proteins, others contain recombinant FeLV surface proteins. Most vaccines include adjuvants to enhance effectiveness. A newer live virus vaccine uses a canary pox vector expressing FeLV genes. Previous studies on FeLV pathogenesis and vaccines were done before sensitive molecular diagnostic tests were available. Recent research using these tests showed that detecting FeLV DNA is more sensitive than antigen detection or virus isolation for assessing FeLV exposure. This led to identifying four categories of FeLV-host relationships after exposure. However, little was known about plasma viral RNA levels in these categories. Recent studies have begun to quantify provirus and viral RNA loads during FeLV vaccination, shedding light on the host-virus interaction. This study aims to provide insights into this interaction using sensitive molecular assays (Hofmann-Lehmann et al., 2007).

Feline Leukaemia Virus (FeLV)

Feline leukaemia virus (FeLV) is a retrovirus that can cause immune system suppression, anemia, and/or lymphoma. In the last 25 years, the prevalence of FeLV infection has been significantly decreased attributed to dependable tests for identifying carriers with the virus and to efficient vaccines (Hofmann-Lehmann and Hartmann, 2020).

Infection

Transmission among cats primarily happens through close interactions, including friendly contact and biting. In extensive populations of cats not vaccinated, approximately 30–40% will develop continuous viraemia, 30–40% experience temporary viremia, and 20–30% undergoes seroconversion. Young kittens are particularly vulnerable to FeLV infection.

Disease Signs

The primary symptoms of persistent FeLV viremia include immune suppression, anemia, and lymphoma. Less frequent symptoms include immune-related ailments, long-term inflammation of the intestines, reproductive problems, and peripheral neuropathies. The majority of cats with continuous viremia typically pass away within 2–3 years.

Diagnosis

In regions with low prevalence, there might be a chance of incorrect positive outcomes; hence, a potentially positive test outcome in a healthy cat should be verified, ideally through PCR for provirus. Asymptomatic cat’s positive for FeLV should undergo retesting.

Disease Management

Cats with FeLV need to be kept indoors and receive supportive care. Prompt treatment is needed for any secondary infections. It's important to continue vaccinating against common diseases using inactivated vaccines. The virus cannot last lengthy periods of time outside the body.

Vaccination Recommendations

All cats whose FeLV status is unknown should be tested prior to vaccination. Healthy cats which might be exposed to FeLV should be vaccinated against it. The first vaccination should be given to kittens between 8 and 9 weeks, the second at 12 weeks, and the booster one year later. Because they are less susceptible, cats older than 3–4 years old should have a booster every 2-3 years (Lutz et al., 2009).

Feline Immunodeficiency Virus (FIV)

Feline Immunodeficiency Virus (FIV) is another viral disease that weakens a cat's immune system, similar to HIV in humans. Vaccines for FIV exist, but their efficacy and necessity are still debated. FIV vaccines are not considered core vaccines and are typically only recommended in certain situations, such as for cats at high risk of exposure to the virus.

Feline the immunodeficiency virus (FIV) is a retrovirus closely linked to the human the immunodeficiency virus. While most felines can contract FIV, humans cannot. Feline the immunodeficiency virus is widespread in domestic cat populations globally. The virus rapidly loses its ability to infect outside the host and is vulnerable to all disinfectants (Hofmann-Lehmann et al., 2007).

Infection

Transmission of feline immunodeficiency virus occurs through bites. The likelihood of transmission is minimal in households with socially well-adjusted cats. Transmission from mother to kittens is possible, particularly if the queen is experiencing an acute infection. Cats with FIV remain infected persistently despite their capability to produce antibodies and activate cell-mediated immune responses.

Disease Signs

Affected cats typically show no clinical symptoms for several years, and in some cases, they never display any signs of illness, depending on the strain of the virus. The majority of clinical symptoms result from immunodeficiency and subsequent infections. Common manifestations include chronic gum inflammation, persistent nasal inflammation, swollen lymph nodes, weight loss, and immune-mediated kidney inflammation.

Diagnosis

Positive ELISA results acquired in a low-prevalence or low-risk group should consistently be verified by a laboratory. Western blot serves as the definitive laboratory test for FIV serology. PCR-based tests differ in their performance.

Disease Management

Cats should not be euthanized only because they test positive for FIV. Cats with FIV may have a similar lifespan to uninfected cats if they are properly cared for. Asymptomatic cats with FIV should be spayed or neutered to prevent fighting and the spread of the virus. Infected cats should undergo routine veterinary check-ups. They can share the same ward with other patients, but they should be kept in separate cages (Osorio et al., 1999).

Vaccination Recommendations

Currently, there is no commercially available FIV vaccine in Europe. The potential advantages and drawbacks of vaccinating FIV-infected cats should be evaluated on a case-by-case basis. Needles and surgical tools utilized on cats with FIV may spread the virus to other cats, thus stringent cleanliness is crucial (Hosie et al., 2009).

Rabies

Humans can get the viral illness rabies, which damages the central nervous system. Vaccination against rabies is essential for all cats, as it not only protects the cat but also helps prevent the spread of rabies to humans and other animals. Many regions often mandate rabies vaccination by law.

Since the late 1800s, scientists have been working to create better vaccines for rabies, a deadly disease caused by the rabies virus. Although many developed countries have controlled the disease in pets, it still poses a threat in other parts of the world (Aubert, 1992).

Three proteins in RV named N, P and L along with single stranded RNA forms Ribonucleoprotein (RNP). This RNP is covered with spike Glycoprotein and Matrix protein(M). The DNA plasmids vectors in DNA vaccines trigger the immune response due to which antibodies are produced and Cytotoxic T-Lymphocytes are activated (the same response that is produced due to live vaccines).

DNA vaccines' safety and efficacy have primarily undergone examination in mice. However, research has indicated their capability to elicit robust reactions in larger creatures such as ferrets, pigs, cattle, and non-human primates. Previous studies with DNA vaccines containing the rabies glycoprotein G proved to protect mice. In this study, we looked at how a rabies virus DNA vaccine given to dogs and cats through injections into the muscle and skin produced antibody responses. We used various delivery methods and doses of DNA to assess the results (Osorio et al., 1999).

Modern veterinary vaccines are stronger than older versions. However, because no vaccine works perfectly, and some may not work well against certain strains, vaccinated animals still need to be watched closely if they're involved in a biting

incident. This observation period is required for dogs, cats, and sometimes ferrets in some countries. Also, even if a pet is vaccinated, if there's a suspicion of rabies, the animal may still need to be euthanized, regardless of how good the vaccine is (Adedeji et al., 2010).

Bordetella Bronchiseptica

This bacterium is frequently linked with respiratory ailments in cats. Vaccination against Bordetella is generally advised for cats in settings where they face increased exposure risks, such as multi-cat households or boarding facilities. A major pathogen in domestic cats, *Bordetella bronchiseptica* is a Gram-negative bacteria that colonizes the respiratory system of animals. It is prudent to view *B. bronchiseptica* as an infrequent source of zoonotic infections. The bacterium is vulnerable to communal antiseptics.

Infection

The bacterium is released in the nasal and oral discharges of cats that are infected. Dogs suffering from respiratory illness pose a risk of infection for cats. The microorganism forms colonies on the ciliated epithelium of the host's respiratory tract, leading to chronic infections.

Disease Signs

B. bronchiseptica infection has been linked to a broad spectrum of respiratory symptoms, ranging from mild symptoms like sneezing, fever, eye discharge, coughing, and swollen lymph nodes to pneumonia with difficulty breathing, bluish discoloration, and fatalities.

Diagnosis

Bacterial culture and PCR demonstrate limited sensitivity. Samples for segregation can be collected from the oropharynx (using swabs) or through Tran's tracheal wash/bronchoalveolar lavage.

Disease Management

Even if symptoms are mild, it's important to treat bacterial infections. When we don't have sensitivity data, tetracyclines like doxycycline are recommended. Cats with severe infections need intensive care. Nasal vaccination with a modified live vaccine provides protection within 72 hours and immunity for at least a year against *B. bronchiseptica* infection. Widely using this vaccine, especially in at-risk animals, can aid in lowering *B. bronchiseptica*-induced feline upper respiratory tract illness (Williams et al., 2002).

It's important to note that vaccination recommendations may vary based on factors such as a cat's age, health status, lifestyle (indoor vs. outside), and geographic location. Therefore, it's best to consult with a veterinarian to determine the most appropriate vaccination protocol for your cat.

Conclusion

A fundamental comprehension of vaccine components and enhancers, along with the advantages and limitations of weakened and incapacitated formulations, is essential for informed vaccine decision-making. The commencement of an early protective reaction serves as guidance for the development of primary immunization regimens, and the duration of protection (based on challenge studies) remains uncertain for each pathogen or product. Finding that protection to some viruses may continue over decades but immunity to others would only survive for months (with existing vaccination technology) would not be surprising. The likelihood that a patient may have a serious disease in comparison to the possible hazards of vaccine-related consequences should be taken into consideration while making the choice to vaccinate (Kruth and Ellis, 1998).

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