SINGAPORE VACCINATION GUIDELINES FOR DOGS AND CATS

2020

ANIMAL & VETERINARY SERVICE

SINGAPORE VETERINARY ASSOCIATION

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Foreword

From Director-General of NParks/AVS, Dr Yap Him Hoo

It is heartening to see the strong collaboration within our veterinary professional community in developing our very first Singapore Vaccination Guidelines for Dogs and Cats. The publishing of these guidelines is an important step in raising healthcare standards for our companion animals, as vaccination is an essential tool in preventing life-threatening infectious diseases of animals. It is important also to recognize that animal health is closely linked to public health, and that the prevention of zoonotic disease in animals will greatly reduce the risk of disease spread to humans.

Our veterinary profession, pet owners and animal-related businesses, all play crucial roles in protecting the health and welfare of our companion animals. I hope that these guidelines will raise awareness and understanding of good vaccination practices, as well as standardize these practices across all stakeholder groups. The recommendations in these guidelines are backed by robust scientific evidence, and are also tailored to Singapore's context. I look forward to the future collaborations and initiatives in the veterinary and pet communities, which will improve the lives of our animals and the people they interact with, as well as the environment that we all live in.

From SVA President (2019), Dr Timothy Chua

Vaccination has always been one of the fundamental pillars of disease prevention for animals. Globally, there has been a strong push for One Health, where both human health and animal health are closely intertwined. It is timely and a great pleasure for Singapore Veterinary Association to partner with the National Parks Board, Animal and Veterinary Service, to create a Vaccination Guideline for pets specifically catering to our local context. This guidelines, being a historic first in Singapore, is an important milestone.

The guidelines are meant for both the veterinary profession, pet owners and public at large. SVA, through this set of guidelines, seeks to inform and educate readers about the importance of vaccination for animal health. The guidelines also add on a local favour and is tailored to Singapore's disease prevalence.

Together, I hope that you can partner us in promoting the use of vaccination to safeguard both human and pet health.

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Statement from SVA

The Singapore Veterinary Association (SVA) strongly supports and recommends evidence-based practices of vaccination for the control of infectious diseases in animals. While adverse and unwanted reactions may occasionally occur, the overall cost-benefit analysis strongly supports the continued use of high-quality and approved veterinary vaccines to control infectious diseases. This will safeguard animal health and welfare. In addition, vaccination of animals will protect public health in humans by reducing potentially zoonotic diseases and combatting antimicrobial resistance.

The SVA strongly supports practice of evidence-based veterinary medicine, including vaccination. The SVA strongly supports the prudent use of antimicrobials and recognises that vaccination is an important tool to combat antimicrobial resistance. In addition, veterinarians are well-positioned to play a role in informing and educating pet owners on this subject. The SVA strongly supports further research into improving the efficacy and safety of vaccines and recognises the importance of pharmacovigilance and prompt reporting of suspected adverse reactions to veterinary vaccines.

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Abbreviations

AVS: Animal and Veterinary Service

CAV: Canine adenovirus

CDV: Canine distemper virus

CIV: Canine influenza virus

CIRDC: Canine infectious respiratory disease complex

CPV: Canine parvovirus

FCV: Feline calicivirus

FHV: Feline herpesvirus

FIV: Feline immunodeficiency virus

FeLV: Feline leukaemia virus

FPV: Feline parvovirus; feline panleukopenia virus

MDA: Maternally-derived antibodies

MLV: Modified live virus

NParks: National Parks Board

SVA: Singapore Veterinary Association

WSAVA: World Small Animal Veterinary Association

Introduction

Vaccination is widely regarded as one of the most cost-efficient means of improving animal health and is a cornerstone of preventative healthcare in animals. Vaccines protect the health of our pets, food-producing animals, and working animals, preventing debilitating and life-threatening diseases, and ensuring security in our food supply and sustainability in agricultural industries globally. The vaccination of domestic animals is also essential to public health and biodiversity, protecting people from zoonotic diseases, and wildlife from diseases that may spread across species.

In Singapore, there is a rapidly growing need to ensure that our companion animals are adequately vaccinated. The population of owned pets has surged over the years, with the number of licensed dogs increasing by almost 20% from 59,000 in 2011 to about 70,000 in 2019. As a cosmopolitan society and travel hub with large numbers of people and pets travelling across our borders (about 2000 pets were imported in 2018), it is paramount to ensure that our pets are vaccinated to protect them from infectious diseases found in different parts of the globe.

Singapore is also unique in its high population density and urban living environment, with animals and people living in close and frequent contact. The pet community here is becoming more active and vibrant, with increased interactions of pets in common spaces due to more pet events and gatherings being organised and receiving greater attendance, and more pet-friendly spaces becoming available, such as dog runs and pet-friendly eateries. Changing social attitudes towards the value of animals and their importance in people's lives, as well as rising affluence, have increased the amount of attention and quality of care provided to our animals. All these highlight the need for vaccination guidelines that are suited to our local context to ensure the health of our companion animals.

Historically, a one-size-fits-all approach was taken for vaccinations. Our current understanding is that vaccination should be personalized, with a protocol designed for the benefit of the individual pet. The lifestyle and environment of the pet and owner should also be taken into account. In addition to vaccination, good hygiene, biosecurity, husbandry (diet and environment), and other preventative healthcare measures, are essential to provide animals with the best level of protection against diseases.

Our approach to disease prevention must evolve as scientific developments arise and improve our understanding of vaccines and vaccine-preventable diseases, such as the prevalence of the disease or the presence of different pathogen serovars. Together with the increase in the number of practising veterinarians in Singapore, it is important to harmonise vaccination practices across the country and provide an easily accessible guide containing updated and evidence-backed recommendations.

The Singapore Vaccination Guidelines Working Group was established in September 2019 to evaluate and consolidate existing recommendations and formulate a set of guidelines that is suited to our local context. The working group comprises veterinarians across different fields. The working group has produced the following set of guidelines for the vaccination of dogs and cats, addressing key topics including vaccine schedules and good practices. The guidelines are based on current scientific evidence and will be reviewed on a regular basis.

Scope

These guidelines are not a mandate but are intended to provide guidance to veterinarians practising in Singapore. The recommendations should be adapted to individual animals based on clinical

assessment by a veterinarian. These guidelines do not supersede the import and export requirements of other countries where certain vaccination types and schedules may be mandatory or specified.

Format of Guidelines

The guidelines are formatted as such:

- The sections are split into canine and feline vaccines, and are further subdivided into core and non-core vaccines
- Each disease covered by the vaccines is stated and briefly elaborated upon, followed by the vaccine recommendations
- Recommended vaccination schedules are written in boxes in their respective sections

Core and Non-Core Vaccines

The guidelines broadly split vaccine types into 2 categories, which are core and non-core vaccines.

For the purposes of these guidelines, core vaccines are defined as vaccines which all dogs and cats, regardless of circumstance or geographical location, should receive. Core vaccines protect animals from severe, life-threatening diseases known to be present in Singapore.

In Singapore, the core vaccines protect against the following:

Dogs	Cats
● Canine distemper virus (CDV) ● Canine adenovirus (CAV) ● Canine parvovirus (CPV)	● Feline parvovirus; feline panleukopenia virus (FPV) ● Feline calicivirus (FCV) ● Feline herpesvirus (FHV)

Non-core vaccines are used to protect dogs and cats from diseases when certain factors, such as their geographical location, lifestyle, or environment, put them at risk. While all dogs and cats should be vaccinated with core vaccines, non-core vaccines should be considered in specific circumstances. A veterinarian should be consulted to customise a vaccination programme suited to the needs of the animal and its environment. Further information on the relevant risk factors for the diseases covered by the non-core vaccines are provided in the subsequent sections.

Serological Testing

Serological testing is a tool for measuring circulating serum antibodies to a particular organism or antigen in animals. Results from serological tests may be quantitative (antibody titre value) or qualitative (positive or negative) in nature. Antibody titre value is the amount of antibodies within an animal's blood, which is typically correlated to the level of antibody-mediated immune protection the animal has against a specific disease. It does not provide an indication of cell-mediated immune response to an organism, which may provide some level of protection.

Currently, there are serological tests that reliably demonstrate protective antibody titres for CPV-2, CDV, CAV, and FPV[1]. For these diseases, the presence of serum antibody (regardless of the titre) in vaccinated animals over 20 weeks of age correlates with immune protection.

In general, a positive test result indicates that the animal has sufficient amount of antibodies and protective immunity against the specific disease. A negative test result indicates that the animal has an insufficient amount of antibodies and revaccination is recommended. Interpretation of the test results is largely dependent on the objective for which the test was carried out and the test specifications (e.g. sensitivity and specificity).

It is important to note that a positive test result or the presence of significant levels of antibody does not provide full assurance for protection against infection and disease. In addition, a negative test result or low antibody titres does not always correlate to susceptibility to infection. Antibody levels may fall below detectable levels in the absence of exposure, including revaccination. In some adult animals that have shown protective titres previously, exposure to a pathogenic virus may induce a rapid anamnestic protection due to immunologic "memory", even when the last vaccination was administered years ago[i]. Because such animals cannot be detected readily, revaccination is still recommended to re-establish humoral response above the protective immunity threshold, unless a veterinarian has assessed that there is a medical reason not to revaccinate[ii].

Serological testing can be applied to the following situations:

1. **Determining Vaccine-Induced Immunity in Puppies or Kittens**

Following the primary course of vaccination, owners may wish to confirm if the course has induced protective immunity in their puppies or kittens. Veterinarians may offer clients serological tests available for vaccine-preventable diseases. Testing also allows the identification of individuals that are genetic non-responders and are unable to mount a protective antibody response despite being properly vaccinated.

As a guide, a serum sample should be collected and tested at least 2 to 4 weeks after the final vaccination has been administered and when the animals are of a sufficient age to decrease risk of interference of maternally-derived antibodies (MDA). Puppies or kittens with non-satisfactory seroconversion should be revaccinated and retested to assess antibody response.

[1] Serological testing for FCV and FHV-1 is less useful as protection is largely attributed to local mucosal immunity and cell-mediated immunity respectively.

2. Determining Revaccination Interval in Adult Dogs and Cats

As immune protection conferred by vaccination is sometimes not life-long, serological testing could be an option for veterinarians to assess the immune response of an animal and demonstrate the duration of immunity post-vaccination. For adult animals with a low risk of infection (e.g. always kept indoors, little to no contact with other animals), some veterinarians may recommend an off-label booster interval following an assessment that the animal has achieved adequate antibody titre values. If the animal has a history of adverse reaction to a core vaccine or has been suspected to be a poor-responder to vaccination, serological testing may also be used as a tool to determine the need to adjust the interval of revaccination.

Regardless of the revaccination interval, it is strongly recommended for animals to undergo routine veterinary visits at least once a year. This allows veterinarians to review the health status of the animal regularly, better understand its lifestyle and risk of infection, as well as maintain the veterinarian-client-patient relationship.

3. International Pet Travel

On some occasions, importing countries may specify serological testing for rabies or other pathogens in their import requirements. Veterinarians are reminded to exercise diligence and understand the requirements of the importing country. Animals should be accurately identified and thoroughly inspected prior to the issuance of veterinary health certificates. Inaccurate certification and improper examinations pose a serious risk to public health and animal health of the importing country and could potentially cause the export consignment to be rejected and subsequently affect future live animal exports from Singapore. It is imperative to adhere to the importing country requirements when administering vaccines.

Canine Core Vaccines

The core vaccine recommendations for dogs in Singapore do not differ greatly from that of most other countries. Core vaccines serve to protect a dog especially when it interacts with other animals of unknown health and vaccination status. An unvaccinated dog is not only susceptible to these vaccine-preventable diseases, it may also act as an additional transmission host capable of spreading the disease to other animals (e.g. when an infected dog visits a dog park, it may be shedding viruses which can be picked up by other dogs).

Veterinarians will encounter clients who keep their dogs entirely indoors. Although these dogs may be at lower risk of exposure to pathogens, they are still susceptible to infection through transmission via air or infectious material that clients may inadvertently introduce to their homes (e.g. particles on clothes or footwear).

Whether the population is low- or high- risk will affect the frequency of core vaccinations and requirements for non-core vaccines, as detailed in the respective sections.

Canine Parvovirus

Pathogen: Canine parvovirus type 2 and its variants (CPV-2a, CPV-2b, and CPV-2c)

Canine parvovirus is shed in the faeces of infected dogs. Transmission is through direct contact with infected faeces or indirect contact through faecal contamination of objects, people, and environments. Puppies less than 20 weeks of age are most vulnerable to the disease. However, unvaccinated dogs of all ages are susceptible. The virus can survive in warm environments for months and is vulnerable to disinfectants such as dilute bleach solution (1:30 dilution) and potassium peroxymonosulfate (e.g. Virkon)[iii].

While there has been no study on the disease prevalence in Singapore, the disease has been reported by veterinary practices locally. In a few studies, it was reported that CPV-2a and CPV-2b are the predominant strains in Asian countries[iv,v]. The CPV-2c strain has also been detected in Singapore based on findings from the Centre for Animal & Veterinary Sciences in NParks/AVS, and has been documented in India, China, Vietnam, and Taiwan[iv,v]. Additionally, CPV-2c infections have been reported in wild Asian palm civets in Singapore, indicating possible disease transmission from domestic dogs and stray dogs to wild animals[vi].

The current vaccines provide protection against all the known variants of CPV-2.

Risk Factors:

Outdoor environments where dogs are present (e.g. dog runs, grassy patches) could pose a risk of exposure if an infected animal has been through that area.

Facilities where dogs are housed at high density (such as shelters or boarding facilities) and events where large numbers of dogs are gathered pose a higher risk if dogs are not adequately vaccinated.

Smuggled dogs and stray dogs in Singapore with unknown vaccination status are of higher risk.

Canine Distemper Virus

Pathogen: Canine distemper virus and its variants (CDV)

Canine distemper virus is shed in all body fluids of infected dogs, such as saliva and urine. The primary mode of transmission is via inhalation (e.g. aerosol droplets from cough or sneeze). Transmission can also occur through indirect contact with contaminated objects, people, and environments[vii]. Puppies less than 20 weeks of age are most vulnerable to the disease. However, unvaccinated dogs of all ages are susceptible. The virus can survive for a few hours in the environment. It is vulnerable to drying, sunlight, and many common disinfectants such as potassium peroxymonosulfate (e.g. Virkon) and quaternary ammonium compounds[viii].

CDV is still prevalent worldwide, especially in rural areas and places with little vaccination coverage. While there has been no study on the disease prevalence in Singapore, it has been reported by veterinary practices locally.

The current vaccines provide protection against all the known variants of CDV.

Risk Factors:

Refer to Canine Parvovirus – risk factors.

Canine Adenovirus

Pathogen: Canine adenovirus 1 (CAV-1) and canine adenovirus 2 (CAV-2)

CAV-1 causes infectious canine hepatitis (ICH) and is transmitted primarily through direct contact with secretions and excretions from infected dogs, such as saliva or urine. CAV-2 is transmitted through the air and is associated with other pathogens to cause canine infectious respiratory disease complex (CIRDC). Puppies less than 1 year of age are most commonly affected, although unvaccinated dogs of all ages are susceptible[ix]. CAV-1 and CAV-2 are moderately stable and can survive for several days to weeks in the environment. They are vulnerable to disinfectants such as dilute bleach solution (1% sodium hypochlorite)[x].

There have been reported incidences of ICH in Japan, India, China, and Thailand, with the incidences ranging from 17.7% in Japan to 76% in India[xi]. While there has been no study on the disease prevalence in Singapore, it has been reported by veterinary practices locally.

Vaccines containing CAV-2 components are the vaccines recommended for the prevention of ICH (CAV-1) and also for reduction of clinical signs caused by CIRDC (CAV-2).

Risk Factors:

Refer to Canine Parvovirus – risk factors.

Vaccination Schedule for Canine Core Vaccines

Vaccines for canine parvovirus, canine distemper virus, and canine adenovirus are core vaccines in Singapore. They are available as a single vaccine or in combination with non-core vaccine components.

Regardless of the combinations, the recommended vaccination schedule below for puppies, adults, and revaccination would apply.

Recommendation:

Puppy Vaccination Series:

The initial core vaccination should be given at **6 - 8 weeks of age**. Subsequent boosters should be given every **2 - 4 weeks** until **16 weeks of age or older.**

Note: If the initial vaccination is given earlier in the age range of 6 – 8 weeks, there is a higher chance of it not being able to induce adequate immunity due to a higher level of MDA interference. The veterinarian should consider the puppy's situation (e.g. presence of other animals and their vaccination status, likelihood of virus exposure) before recommending the most appropriate vaccination time to the client.

Adult Vaccination Series:

First adult booster - Once the puppy vaccination series has been completed, a booster vaccine is routinely given **within 1 year following the last dose** in the initial vaccination series**.** This vaccine is crucial as it is protective for puppies that did not respond to any of the vaccines in the puppy vaccination schedule.

For adult dogs receiving regular vaccinations:

In Singapore, core vaccines are currently registered for annual booster intervals after the initial puppy vaccinations. However, there has been increasing evidence that certain vaccine products may offer a longer duration of immunity. A veterinarian may recommend off-label booster intervals following an assessment of the dog and after discussing the dog's lifestyle and risks with the client. Off-label use of vaccines should be properly documented in the medical records. Serological testing may be used to assess the immunity level of the dog to better advise the required booster intervals.

For adult dogs with irregular vaccination history:

Adult dogs that have received a complete course of vaccination for core vaccines as puppies, but may not have been regularly vaccinated as adults, require only a single dose of modified live, core vaccines to induce protective immunity.

For adult dogs with unknown vaccination history:

Adult dogs with unknown vaccination history should receive two initial doses of modified live, core vaccines **2 - 4 weeks apart** to induce protective immunity.

Canine Non-Core Vaccines

Leptospirosis

Pathogen: *Leptospira* spp.

Leptospira bacteria are shed in the urine of infected animals. Transmission is primarily via direct contact with infected urine through skin or mucous membranes, or indirect contact with urine-contaminated objects and environments. Rodents found in the environment are known to play a part in the spread of disease. Leptospirosis is zoonotic and can cause disease in both animals and humans. The bacteria survive well in warm and wet climates, and also survive better in stagnant than moving waters. It is vulnerable to disinfectants such as dilute bleach solution (1% sodium hypochlorite) and 70% ethanol.

Leptospirosis is a notifiable disease[2] in Singapore and suspected or confirmed cases must be reported to the AVS. While there has been no study on the disease prevalence in Singapore, the *Leptospira* serovars *canicola*, *icterohaemorrhagiae, pomona and grippotyphosa* have been reported locally based on serological test results. However, other serovars may also be present in Singapore. Studies on *Leptospira* serovars are challenging as microbiologic and molecular diagnostic tests are rarely performed, thus the true infecting serovar is unclear in most cases.

The vaccines for *Leptospira* spp. are serovar-specific, which means that there is no single vaccine that is cross-protective against all the serovars. A vaccinated dog may still become infected and fall ill if it is exposed to a different or novel serovar. However, clinical signs are thought to be less severe in vaccinated dogs.

Risk Factors:

Dogs with potential exposure to urine from infected animals (e.g. live in or frequent areas with rat sightings, shelter or boarding environment), and access to ponds, lakes, or bodies of standing water.

Recommendation:

While Leptospirosis vaccines are currently classified as non-core vaccines in Singapore, the Working Group recognises that many dogs in Singapore would have a degree of exposure risk to *Leptospira* due to the local climate and because complete avoidance of rats, infected animals and their urine in the environment is impractical. As such, dogs with any access to the outdoors or potential exposure to urine from infected animals should be vaccinated to reduce chances of infection and disease severity. There are variations of vaccines containing *Leptospira* components. Some are combined with the core vaccine components while others are available separately. As knowledge of the *Leptospira* serovars in Singapore is incomplete, there could be serovars which are not covered by currently available vaccines in Singapore. The Working Group strongly recommends improving the understanding of serovar prevalence in Singapore. This can be achieved by: 1) Raising clinicians' awareness of the importance

[2] The list of notifiable diseases are listed in the Schedule of the Animals and Birds (Disease) Notification (https://www.nparks.gov.sg/avs/animals/animal-health-and-veterinarians/animal-diseases-and-antimicrobial-resistance/reporting-notifiable-diseases)

of reporting suspect or confirmed cases, and 2) Conducting more local surveillance and/or studies on Leptospirosis in animals. Improved understanding of the local prevalence would contribute to future reviews on whether Leptospirosis vaccines should be re-classified as core vaccines in Singapore.

The current Leptospirosis vaccines registered in Singapore come in various combinations and may cover the following 4 serovars:

- *Leptospira canicola*
- *Leptospira grippotyphosa*
- *Leptospira icterohaemorrhagiae*
- *Leptospira pomona*

Puppy Vaccination Series:

The initial vaccination should be given at **6 - 9 weeks of age or older.** A second dose should be given **2 - 4 weeks later**.

Adult Vaccination Series:

Adult dogs at risk are recommended to be revaccinated **annually** as the immunity conferred by the vaccine is known to provide less robust and shorter period of protection as compared to core vaccines.

For adult dogs with irregular vaccination history:

Adult dogs that have received a complete course of vaccination as puppies but may not have been regularly vaccinated as adults require either a single dose or two doses, **2 - 4 weeks apart** depending on lifestyle and exposure risks.

For adult dogs with unknown vaccination history:

Adult dogs with unknown vaccination history should be given two initial doses of vaccines **2 - 4 weeks apart** to induce protective immunity.

Rabies

Pathogen: Rabies virus

The virus is shed in the saliva of an infected mammal. Transmission is usually through a bite or a scratch from an infected dog. Globally, more than 95% of human cases are caused by the bite of a rabies-infected dog. The virus does not survive well outside its host and is susceptible to sunlight and desiccation.

Singapore has been rabies-free since 1953. However, neighbouring countries are not, and Singapore remains vigilant by implementing precautionary measures to keep rabies out of the country. These precautionary measures include dog licensing to enhance traceability and strict import controls to curb the smuggling of unlicensed animals - which may carry rabies - into Singapore. Rabies is also a notifiable disease and suspected cases must be reported to the AVS.

The AVS carries out rabies vaccination and serology testing of dogs at coastal fish farms and selected offshore islands of Singapore. By vaccinating at least 70% of the at-risk dog population at Singapore's border areas, the risk of rabies incursion in mainland Singapore is reduced.

Risk Factors:
As Singapore is rabies-free, the risk of a pet animal being infected with rabies in Singapore is very low. Smuggled animals in Singapore with unknown health status are of higher risk.

Recommendation:
As the risk of being infected with rabies in Singapore is very low, the rabies vaccine is a non-core vaccine and is not recommended if the pet is not travelling overseas. Vaccination when done should be in accordance to manufacturer's instructions.

Canine Infectious Respiratory Disease Complex (CIRDC a.k.a. Kennel Cough)

Pathogen: *Bordetella bronchiseptica* (most common), parainfluenza virus, canine influenza virus, and others

Canine infectious respiratory disease complex (CIRDC) is a highly contagious respiratory disease caused by several bacterial and viral organisms. The organisms are mainly shed in respiratory secretions. Transmission is through direct contact with infected dogs via inhalation (e.g. aerosol droplets from cough or sneeze) or indirectly via contaminated environments. Most of the organisms do not survive well in the environment and are vulnerable to common disinfectants such as dilute bleach solution (1:30 dilution) and potassium peroxymonosulfate (e.g. Virkon)[xii]. It is important to understand that CIRDC is not a vaccine-preventable disease and the vaccine is used only to help manage the disease.

While there has been no study on the disease prevalence in Singapore, it has been reported by veterinary practices locally.

Risk Factors:

Facilities where dogs are housed at high-density (such as shelters or boarding facilities) and events where large numbers of dogs are gathered pose a higher risk if dogs are not adequately vaccinated.

Recommendation:

Kennel cough vaccines are considered non-core in Singapore. There are variations of vaccines containing kennel cough components. Some are combined with the core vaccine components while others are available separately.

Vaccines should be given according to manufacturer's recommendation; generally two doses **2 - 4 weeks apart** at **6 - 8 weeks of age or older**.

There are intranasal products that can be given as a single dose from **3 weeks of age or older**.

It is highly recommended for owners to ensure that their dog is up-to-date with their kennel cough vaccinations prior to boarding. As a guide, dogs should be vaccinated approximately **2 - 3 weeks prior to exposure** to facilities or events where there are high densities of animals.

Dogs would need to be revaccinated annually if the risk continues to be present.

<u>Canine Coronavirus</u>

Pathogen: Canine coronavirus

Canine coronavirus causes mild or subclinical gastrointestinal disease and is transmitted primarily through direct contact with infected faeces. Most dogs typically get infected at 6 weeks of age or younger. Except for young puppies that may develop severe, fatal enteritis, the disease is generally self-limiting and most dogs recover without treatment. There is currently a lack of evidence that canine coronavirus is a significant primary enteric pathogen in the adult dog.

Recommendation:

Based on the disease characteristics, canine coronavirus vaccine is not required. However, In Singapore, canine coronavirus vaccines exist as a combination with other core and non-core vaccine components and are often administered together.

Feline Core Vaccines

The core vaccine recommendations for cats in Singapore do not differ greatly from that of most other countries. Core vaccines serve to protect a cat especially when it interacts with other animals of unknown health and vaccination status. An unvaccinated cat is not only susceptible to these vaccine-preventable diseases, it may also act as an additional transmission host capable of spreading the disease to other animals (e.g. when the infected cat enters a boarding facility or is allowed to roam outdoors).

Veterinarians will encounter clients who keep their cats entirely indoors. Although these cats may be at lower risk of exposure to pathogens, they are still susceptible to infection through transmission via air or infectious material that clients may inadvertently introduce to their homes (e.g. particles on clothes or footwear).

Cats that live in purely indoor, single-cat households can be considered a low-risk population due to the lack of interaction with other animals. Cats living in multi-cat households, or with outdoor or semi-outdoor lifestyles, can be considered a high-risk population as they are exposed to other animals with varied or unknown health statuses.

Whether the population is low- or high-risk will affect the frequency of core vaccinations and requirements for non-core vaccines, as detailed in the respective sections.

Feline Parvovirus

Pathogen: Feline parvovirus; feline panleukopenia virus (FPV)

Feline parvovirus is shed from all body secretions of infected cats. Transmission is primarily via indirect contact with contaminated objects and environments, or via direct contact with infected cats. The virus can survive up to 1 year at room temperature in organic material on solid fomites. It is vulnerable to disinfectants such as dilute bleach solution (1:32 dilution) and potassium peroxymonosulfate (e.g. Virkon)[xiii]. Kittens less than 20 weeks of age are most vulnerable to the disease. However, unvaccinated cats of all ages are susceptible.

While there has been no study on the disease prevalence in Singapore, it has been reported in veterinary practices locally.

Risk Factors:

Cats that encounter unvaccinated cats (e.g. with an outdoor or semi-outdoor lifestyle or entering boarding facilities with no vaccination requirements) are at higher risk.

Smuggled kittens and stray cats in Singapore with unknown vaccination status are also of higher risk.

Feline Calicivirus

Pathogen: Feline calicivirus (FCV)

Feline calicivirus is mainly shed in ocular, nasal, and oral secretions. Transmission is primarily by direct contact with an infected cat and can also occur by indirect contact with contaminated objects and

environments. Aerosol spread of FCV is not thought to be of major importance; however, sneezed macro droplets may transmit infection over 1 to 2 metres[xiv]. Unvaccinated cats of all ages are susceptible to infection. The virus is vulnerable to many common disinfectants such as potassium peroxymonosulfate (e.g. Virkon) and dilute bleach solution (1:32 dilution)[xiii].

While there has been no study on the disease prevalence in Singapore, it has been reported in veterinary practices locally.

Although vaccination can induce some degree of cross-protection against different FCV strains, cats can still be sequentially infected with different strains of the virus and show varying degrees of clinical illness. There is ongoing discussion on the efficacy of cross-protection provided by strains used in current FCV vaccines.

Risk Factors:

Cats that encounter unvaccinated cats (e.g. with an outdoor or semi-outdoor lifestyle or entering boarding facilities with no vaccination requirements) are at higher risk.

Feline Herpesvirus

Pathogen: Feline herpesvirus-1 (FHV-1)

The transmission routes of FHV-1 are similar to FCV. However, FHV-1 is more susceptible to common disinfectants such as dilute bleach solution (1:32 dilution). Almost all cats that have recovered from FHV-1 infection become latently infected carriers and can shed the virus after periods of stress.

While there has been no study on the disease prevalence in Singapore, it has been reported in veterinary practices locally.

Risk Factors:

Cats that encounter unvaccinated cats (e.g. with an outdoor or semi-outdoor lifestyle or entering boarding facilities with no vaccination requirements) are at higher risk. Introduction into new or stressful environments such as cat boarding facilities and shelters may also lead to reactivation of latent infections in carriers.

Vaccination Schedule for Feline Core Vaccines:

Vaccines for feline parvovirus, feline calicivirus, and feline herpesvirus are core vaccines in Singapore. They are available as a single vaccine or in combination with non-core vaccine components.

Regardless of the combinations, the recommended vaccination schedule below for kittens, adults, and revaccination would apply.

Recommendation:

Kitten Vaccination Series:

The initial core vaccination should be given at **6 - 8 weeks of age**. Subsequent boosters should be given every **2 - 4 weeks** until **16 weeks of age or older**.

Note: If the initial vaccination is given earlier in the age range of 6 – 8 weeks, there is a higher chance of it not being able to induce adequate immunity due to a higher level of MDA interference. The veterinarian should consider the kitten's situation (e.g. presence of other animals and their vaccination status, likelihood of virus exposure) before recommending the most appropriate vaccination time to the client.

Adult Vaccination Series:

First adult booster - Once the kitten vaccination series has been completed, a booster vaccine is routinely given **within 1 year following the last dose** in the initial vaccination series. This vaccine is crucial as it is protective for kittens that did not respond to any of the vaccines in the kitten vaccination schedule.

For adult cats receiving regular vaccinations:

In Singapore, core vaccines are currently registered for annual booster intervals after the initial kitten vaccinations. However, there has been increasing evidence that certain vaccine products may offer a longer duration of immunity. A veterinarian may recommend off-label booster intervals following an assessment of the cat and after discussing the cat's lifestyle and risks with the client. Off-label use of vaccines should be properly documented in the medical records.

For adult cats with irregular vaccination history:

Adult cats that have received a complete course of vaccination for core vaccines as kittens, but may not have been regularly vaccinated as adults, require only a single dose of modified live, core vaccine to induce protective immunity.

For adult cats with unknown vaccination history:

Adult cats with unknown vaccination history should receive two initial doses of modified live, core vaccines **2 - 4 weeks apart** to induce protective immunity.

Feline Non-Core Vaccines

Feline Leukaemia Virus

Pathogen: Feline leukemia virus (FeLV)

FeLV is shed in body fluids such as saliva, urine, faeces, and milk of an infected cat. Transmission is primarily via close contact with infected cats (e.g. through behaviours like mutual grooming, mating, fighting), and also via indirect contact with contaminated objects (e.g. sharing food or water bowls and litter boxes). It can also be transmitted via blood transfusions and contaminated surgical or dental equipment, as well as vertically from queen to kitten in utero or through nursing. Retroviruses, including FeLV, are generally unstable outside their host, and are inactivated within a very short time on dry surfaces and by common detergents and disinfectants such as dilute bleach solution (0.16% sodium hypochlorite)[xv].

FeLV is one of the most significant and important feline infectious diseases found worldwide. In Singapore, previous studies have reported a prevalence of 9% to 24% for FeLV in cats[xvi].

Risk Factors:

Cats living in multi-cat household with cats that are FeLV-positive or with unknown FeLV status are at risk. Cats with outdoor access are also at risk due to possibility of interacting with other cats of unknown FeLV status.

Recommendation:

FeLV vaccines are non-core vaccines in Singapore. Cats with increased risks of exposure are recommended to be vaccinated to reduce chances of infection and disease severity.

Kitten Vaccination Series:

The initial vaccination should be given at **8 weeks of age or older**. A second dose should be given **3 - 4 weeks later**.

All kittens should be tested prior to FeLV vaccine administration and only FeLV-negative kittens should be vaccinated.

Adult Vaccination Series:

First adult booster - Once the kitten vaccination series has been completed, a booster vaccine is given **1 year later** for all cats.

Subsequently, revaccination should be considered after assessment of the individual's risk factors by a veterinarian. Cats that are not at risk (e.g. fully indoors and from a household with only FeLV-negative cats) are not revaccinated unless there is occurrence of any event or incident that exposes them to FeLV.

For cats that are at risk of exposure, revaccination is recommended. In Singapore, FeLV vaccines are currently registered for annual booster intervals after the initial kitten vaccinations. However, there has been increasing evidence that certain vaccine products may offer a duration of immunity that is longer. A veterinarian may recommend off-label booster intervals following an assessment of the cat and after discussing with the client on the cat's lifestyle and risks. Off-label use of vaccines should be properly documented in the medical records.

For adult cats with irregular vaccination history:

Adult cats that have received a complete course of vaccination for core vaccines as a kitten but may not have been regularly vaccinated as an adult should be tested negative prior to vaccination.

For adult cats that were last vaccinated within the last 3 years, a single dose can be administered to induce protective immunity. For adult cats that were last vaccinated more than 3 years ago, two doses can be administered **3 - 4 weeks apart**, followed by another booster **1 year later**. Subsequent revaccination can be done at an interval recommended by the veterinarian based on risk assessment of the individual cat.

For adult cats with unknown vaccination history:

Adult cats receiving FeLV vaccinations for the first time should be tested prior to administration of the vaccine. After testing negative, they should receive two doses **3 - 4 weeks apart**. A booster vaccination is required **1 year later**. Subsequent revaccination can be done at an interval recommended by the veterinarian based on risk assessment of the individual cat.

Feline Immunodeficiency Virus

Pathogen: Feline immunodeficiency virus (FIV)

FIV is shed in the saliva of infected cats. Transmission is primarily via bite wounds, and also through direct sustained contact with infected cats. Vertical transmission from infected queens to their kittens is possible but occurs rarely. It can also be transmitted via blood transfusions and contaminated surgical or dental equipment, including reused suture material[xvii]. As with other retroviruses, FIV is generally unstable outside the host, and is inactivated within a very short time on dry surfaces and by common detergents and disinfectants such as dilute bleach solution (0.16% sodium hypochlorite).

FIV is one of the most significant and important feline infectious diseases found worldwide. In Singapore, a previous study reported a prevalence of 16% in the sample population being positive for FIV antibodies[xvi].

Risk Factors:

Cats living in multi-cat households with cats that are FIV-positive or with unknown FIV status are at risk. Cats with outdoor access are also at risk due to possibility of interacting with other cats of unknown FIV status.

Multiple studies have also demonstrated that intact male cats are at higher risk, as they are more likely to roam and fight.

Recommendation:

FIV vaccines are non-core vaccines in Singapore. FIV vaccines are strain dependent and currently, the strain present in Singapore is unknown. Given this, protection conferred by the vaccines available locally cannot be concluded.

For kittens and cats assessed to be at risk by a veterinarian, testing should be performed prior to starting vaccination. In Singapore, FIV vaccines are currently registered for initial vaccination in kittens from 8 weeks of age or older, followed by two boosters at intervals of 2 - 4 weeks, and annual booster intervals after this initial series.

In these instances, clinicians are strongly advised to discuss potential risks versus benefits with the owners. Vaccination records must be kept diligently, and owners must be made aware that vaccination may interfere with future in-house test results, making it difficult to diagnose active infection in the cat.

Feline Chlamydiosis

Pathogen: *Chlamydia felis*

The bacteria are shed in secretions such as ocular discharge from an infected cat. *C. felis* does not survive outside of the host so close contact between cats is required for transmission. The bacteria are vulnerable to common disinfectants such as 70% ethanol and dilute bleach solution (1:32 dilution)[xviii]. Although occasional *C. felis* infection has been reported in humans[xix], the risk of zoonotic infection is negligible.

While there has been no study on the disease prevalence in Singapore, it has been reported in veterinary practices locally.

Risk Factors:

High-density cat housing environments (e.g. catteries, multi-cat households) pose a higher risk if cats are not adequately vaccinated.

Recommendation:

Although *C. felis* vaccines are non-core vaccines in Singapore, *C. felis* is typically combined with core vaccine components[3] and thus may be routinely administered concurrently.

Rabies

Pathogen: Rabies virus

Like dogs, cats are susceptible to rabies. However, cats are not generally recognised as a key transmission host in the spread of the disease. Singapore has been rabies-free since 1953. However, neighbouring countries are not, and Singapore remains vigilant by implementing precautionary measures to keep rabies out of the country.

Risk factors:

The risk of a cat in Singapore being infected with rabies is very low. Smuggled cats in Singapore with unknown health status are of higher risk.

Recommendation:

As the risk of being infected with rabies in Singapore is very low, the rabies vaccine is a non-core vaccine and is not recommended if the pet is not travelling overseas. Vaccination when done should be in accordance to manufacturer's instructions.

[3] Single component feline chlamydiosis vaccines are available overseas, and the schedule will vary according to manufacturer recommendations.

Vaccination of Dogs and Cats in the Shelter Environment

Animal shelters, which are typically high-population density environments, differ in many ways from the majority of households with owned pets. For the purposes of these guidelines, shelters refer to facilities that houses multiple animals that are rescued or surrendered and are generally waiting to be rehomed or fostered[4]. Shelters should be distinguished from facilities that house or board fully vaccinated animals for relatively short periods of time (e.g. boarders, grooming facilities, pet hotels, etc.).

In shelters, animals with unknown health status and vaccination histories are often introduced. Some animals may be harbouring infectious diseases at the point of intake, which could go undetected for some time. Newly introduced animals should be considered unvaccinated upon reception into the shelter unless accompanied with the relevant documentation and are strongly recommended to be vaccinated prior to or upon admission.

The typical housing environment in shelters generally comprises a high density of cats and dogs with various levels of immunological competency and of ages varying from young to geriatric. A mixture such as this, coupled with the intrinsic stress of the shelter, poses a higher risk for exposure to pathogen shedding and clinical disease. Hence, it is important to develop plans to identify, control, and prevent the spread of potentially infectious diseases between animals.

Shelters that do not vaccinate on entry, or do not vaccinate all animals, are much more likely to experience outbreaks of vaccine-preventable diseases. In addition, some shelters operate with varying population turnover rates, and some may face manpower and financial constraints, which could lead to lapses in intake vaccinations or biosecurity practices that could potentially increase the disease burden and transmission within the population.

Vaccination is a critical component of the routine animal health management programme of a shelter, as this will ensure that herd health is maintained.

Vaccination should be accompanied by other disease prevention measures – including good intake protocols, adequate biosecurity measures, appropriate nutrition, a clean environment, and other preventative health management strategies such as parasite preventions. Information such as the details of any vaccination provided while the animal is in the shelter should be recorded and regularly updated.

As protocols and resources would differ from one shelter to another, vaccination protocols should be tailored specifically to the needs and practices of each shelter. The interference of MDA to vaccination should be taken into consideration for vaccination programmes.

[4] The recommendations within the guideline for shelter settings can apply to other high-density housing arrangements (e.g. breeding facilities).

Guidelines for Vaccination in the Shelter Environment:

At minimum, the aim of a vaccination protocol should endeavour for all dogs and cats to have the required immune protection against core vaccine diseases.

Core Vaccines

The use of modified live vaccines is strongly recommended over killed vaccine products for core vaccinations in shelters as modified live vaccines induce a faster immune response.

Puppy and Kitten Vaccination Series:

The initial core vaccination can begin at the time of admission to the shelter and at **4 - 6 weeks of age or older**. Subsequent boosters should be given **every 2 weeks** until **20 weeks of age**, if they are still residing in the shelter.

Adult Vaccination Series:

A single dose is administered at the time of admission, and a second dose should be given **2 weeks later** if the animal is still present in the shelter. If the adult animal is still present in the shelter one year later, they should receive their annual booster to maintain their immunity status.

Note: While vaccinations are not generally recommended for animals that are injured, pregnant, or have concurrent medical conditions, there are exceptions for those in shelter environments. This is because these groups of animals are generally living in a high-density environment and are at higher risk of exposure to infectious pathogens.

Given that there is a potential risk of foetal damage, birth defects, or abortion associated with the use of modified live vaccines in pregnant animals, the veterinarian will have to weigh the benefits of vaccination against the risks of exposure and risks to the litter.

In situations when the new animal may be too debilitated to receive the core vaccines, considerations need to be made to move the animal to a more suitable facility to provide adequate and focused care (e.g. veterinary centre, foster home with no other animals).

Non-Core Vaccines

1. Canine Infectious Respiratory Disease Complex (CIRDC a.k.a. Kennel Cough)

It is important to understand that canine infectious respiratory disease complex (CIRDC), which is caused by various types of viral and bacterial pathogens, does not have a single vaccine to address all of these pathogens. Additionally, CIRDC is not a vaccine-preventable disease and the vaccine is used only to help manage the disease. The risk for CIRDC may be highest when a large number of dogs are housed together in close confinement, such as in shelters. Hence, animal shelters are strongly advised to incorporate vaccination against the more significant vaccine preventable diseases within the CIRDC in their animal health programme.

2. Leptospirosis

As mentioned in the previous chapter, dogs with exposure to urine from infected animals (e.g. other dogs of unknown health status or rats), are more likely to get infected. Hence, animal shelters are strongly advised to incorporate vaccination against Leptospirosis in their animal health programme to reduce chances of infection and disease severity.

Puppy Vaccination Series:

The initial vaccination should be given at **6 - 9 weeks of age or older.** A second dose should be given **2 - 4 weeks** later.

Adult Vaccination Series:

Adult dogs should be given two doses **2 weeks** apart. If the adult animal is still present in the shelter one year later, they should receive their annual booster to maintain their immunity status.

3. Feline leukaemia virus (FeLV) and Feline immunodeficiency virus (FIV)

Cats that are group-housed in shelters with other cats of unknown FeLV or FIV statuses are at higher risk of exposure to these two viruses. Hence, shelters are strongly advised to implement good hygiene and biosecurity measures to reduce the risk of transmission. Shelters which are unable to house cats individually are recommended to conduct FeLV and FIV testing, and subsequently vaccinate FeLV-negative cats, before the cats are introduced. As the protection conferred by the FIV vaccines available locally cannot be concluded, the veterinarian should assess the potential risks versus benefits before administering FIV vaccinations.

Kitten Vaccination Series:

The initial FeLV vaccination should be given at **8 weeks of age or older**. A second dose should be given **3 – 4 weeks** later.

All kittens should be tested prior to FeLV vaccine administration and only FeLV-negative kittens should be vaccinated.

Adult Vaccination Series:

Adult cats should be given two doses **3 - 4 weeks** apart. If the adult animal is still present in the shelter one year later, they should receive their annual FeLV booster to maintain their immunity status.

4. Feline Chlamydiosis

Chlamydia felis is a major cause of conjunctivitis, particularly in shelter environments. In Singapore, vaccines for *C. felis* are combined with core components (FHV, FCV, and FPV). Hence, the schedule will follow that for core vaccines.

Serological Testing

If resources permit, serological testing may be a useful tool for admission of animals into a shelter. A positive result after vaccination provides confidence that an animal has achieved a level of protection from the disease, and may be released from isolation or quarantine, provided other aspects of its health have been assessed to be satisfactory and it has received all necessary treatment in accordance with admission protocols. Conversely, animals with unsatisfactory seroconversion after vaccinations should be revaccinated and reassessed for satisfactory seroconversion prior to release from quarantine and entry into the shelter.

Management of Disease Outbreak in Shelters

In the event of disease outbreak and where resources permit, serological testing can be a useful screening tool to determine the efficacy of vaccinations, as well as to determine the immune status of animals in the shelter.

Seropositive animals have some level of protection against infection and should be separated from immunologically naïve or seronegative animals by keeping them in separate units (and airspace) to avoid cross-contamination.

In addition, given that disease transmission in a shelter setting occurs rapidly due to the high density of animals, there is a high likelihood for naïve animals within the shelter to be exposed to an infectious pathogen. Hence, facilities should avoid introducing new animals to the facility and minimise animal movement until the outbreak has resolved.

Note that it is possible for seropositive animals to still get infected and be contagious or infectious. As such, serological testing and vaccination alone cannot replace good hygiene, biosecurity measures, and husbandry factors, which remain key to protecting animals from infection.

Recommendations for Vaccination in Breeding Animals and their Young

Vaccines should not be administered to pregnant pets unless specifically indicated in the vaccine datasheet. Breeding animals should have their vaccination status maintained with core vaccines, but it is unnecessary to administer vaccines immediately before pregnancy as standard vaccination protocols should provide adequate protective immunity and colostral antibody for offspring. The exception is if there is an ongoing disease outbreak in a shelter environment and a pregnant animal has never been vaccinated.

Maternally-derived antibodies (MDA) confer protection to young puppies and kittens in their early stages of life but interferes with the efficacy of most vaccines. To overcome this interference, multiple core vaccine doses for puppies and kittens as described in previous chapters are therefore recommended.

Young animals intended for sale must meet AVS licensing conditions which specify vaccination requirements. Prospective pet owners should request for the vaccination records of the purchased animals and provide them to their veterinarian during the first veterinary visit of the puppy or kitten. This will help the veterinarian ensure that any incomplete course of puppy and kitten vaccination can be followed up appropriately.

Record Keeping

Similar to individual patient records in a veterinary clinical setting, record keeping is an essential component of an effective vaccination programme for breeding animals. Thorough records and documentation allow traceability, which is important in the management of premises with high densities and numbers of animals. Veterinarians providing services to such premises should capture the records in a way that will enable easy extraction for the information to be used in the event of a disease investigation.

Such records are also useful for formulating the vaccination schedule for the offspring as protection conferred by MDA will need to be considered.

As mentioned above, in accordance with the AVS licensing conditions for the sale of dogs and cats, every breeding animal and their offspring must have a vaccination record bearing details that enable proper identification of each individual animal. These should include:

- Microchip number
- Date of birth
- Sex
- Breed
- Colour and any unique markings

Vaccination details should be documented accordingly (please refer to the section *Documentation and Traceability*). Original peel-off vaccine labels should be affixed to the vaccination record. Any unused labels must be discarded, as each label must only be used for the recipient of the vaccine contained within that particular vial.

General Considerations

- Individualised animal healthcare should encompass physical, behavioural, and nutritional needs as well as preventative care. Vaccination should be considered only as a part of a broader comprehensive health care plan for each animal. As such, routine veterinary visits, on at least an annual basis, are strongly recommended regardless of vaccination schedule.

- When developing a vaccination protocol for the individual animal, veterinarians should consider and regularly re-evaluate a range of factors including signalment, current health status, environment, lifestyle, and travel plans.

- Registration with the AVS is required prior to the import, distribution, sale and use of any veterinary vaccine in Singapore. The registration process includes an evaluation of evidence of safety, efficacy, and potency of the vaccine. Unless there is evidence in current accepted scientific literature to the contrary, veterinarians should in general adhere to the approved vaccine manufacturer's direction of use, such as the vaccination schedule and dosing regimen. Deviation from manufacturer's guidelines by any veterinarian must be evidence-based and defensible.

- For patients with pre-existing health conditions, the decision of whether or not to vaccinate should be made based on a thorough assessment of the patient and evaluation of risks versus benefits.

- Immunosuppressive glucocorticoid therapy has not been shown to interfere with vaccine response. It is, however, recommended to administer any vaccine at least 2 weeks after cessation of glucocorticoid therapy.

- Immunocompromised animals, including those undergoing immunosuppressive or cytotoxic therapy (other than glucocorticoids) for conditions such as cancer or autoimmune disease, should not be vaccinated due to the risk of causing or exacerbating disease.

- In general, an animal should be able to respond to multiple antigens administered simultaneously. However, unless indicated by the manufacturer, veterinarians should never mix different vaccines in the same syringe. It is good practice to deliver different vaccines to different anatomical sites.

- Feline injection site sarcoma (FISS) is a locally aggressive mesenchymal tumour that occurs at injection sites. While the FeLV and rabies vaccines in particular have been associated with the formation of FISS[xx,xxi], these tumours have also been linked to other types of injections, including that of other vaccines and medicines such as antibiotics and long-acting corticosteroids[xxi]. As some adjuvanted vaccines cause local inflammation, it has been suggested that the use of adjuvanted vaccines increases the risk of FISS. However, as yet, the exact role of adjuvants in the development of FISS remains unclear. While the prevalence of FISS in Singapore has not been studied, current estimates in the United Kingdom and North America suggest a prevalence of 1 in every 5,000 to 12,500 cats vaccinated[xxii,xxiii,xxiv].

- While veterinarians have the discretion to decide how best to mitigate and manage the risk of FISS, the following recommendations are generally accepted:

    - Non-adjuvanted vaccines should be administered to cats wherever possible, until further evidence regarding the role of adjuvants in the development of FISS becomes available.
    - Vaccinating as distal as possible on the limb to facilitate complete surgical resection by amputation if required.
    - Vaccines (especially adjuvanted vaccines) or other injectables should not be administered into the interscapular region.
    - Vaccines (especially adjuvanted vaccines) should be administered subcutaneously and not intramuscularly to enable earlier detection of FISS.
    - The actual site of vaccination should be selected based on considerations between the ease of surgical resection in the event that FISS might develop, and safety and practicality.
    - Vaccines should be administered into a different site at different occasions. This site should be documented in the medical records of the animal, and 'rotated' on each occasion.
    - Investigate lumps that arise at injection sites based on the 3-2-1 rule developed by the American Association of Feline Practitioners[xxii], which recommends that an incisional (not excisional) biopsy be performed on any lump that:
        - persists for 3 months or more post-injection, OR
        - becomes larger than 2cm in diameter, OR
        - continues to increase in size 1 month post-injection.

- While cats are more susceptible to injection site sarcoma, it should be noted that the condition has also been documented in dogs and other species. As such, the above recommendations may also be considered for the vaccination of dogs.

Vaccine Usage and Handling

- In order to maintain safety, efficacy, and potency, vaccines must be stored under appropriate conditions from the time of manufacture up to the time it is administered to the animal. The optimum storage temperature for vaccines is generally between 2 to 8^{o}C, unless otherwise specified by the manufacturer.

- Vaccines should be reconstituted and drawn up immediately prior to administration. Pre-drawing of vaccines for use later in the day risks contamination and reduction of vaccine potency.

- Vaccines should not be administered beyond their date of expiry.

- The volume of vaccine recommended by the manufacturer generally represents the minimum immunizing dose, therefore the total amount must be given. Unlike pharmaceuticals that are dose-dependent, vaccines are not based on volume per body mass or size of the animal.

- Use of alcohol swabs to sterilise the vaccination site is not advised as it may lead to inactivation of MLV vaccines.

- Vaccine vials and syringes should be properly disposed of according to current local regulations, as stipulated by the National Environment Agency (NEA). These receptacles should not be reused for any purpose.

Documentation and Traceability

- Vaccination details should be documented in the medical record of the animal. The information to be captured include:

    - Date of vaccine administration
    - Unique identifier of the animal
    - Person administering the vaccine
    - Vaccine name, lot or serial number, expiry date and manufacturer
    - Site and route of vaccine administration

- The label on each vaccine vial should only be intended for the record of the individual animal that was administered the vaccine from that vial. Vaccine labels should be affixed to the animal's vaccination record or certificate and issued to the owner with the official stamp of the veterinarian or veterinary clinic to ensure traceability.

- It is the responsibility of the veterinarian to document any adverse reactions in the medical record of the patient. Any suspected adverse reactions or vaccine failures should be documented and duly reported by the veterinarian to the manufacturer and the AVS to assist with ongoing surveillance of vaccine safety.

- Veterinarians and veterinary clinics should put in place measures to ensure that pet owners whose pets have received a particular vaccine batch can be promptly contacted should there be an issue with the vaccine batch.

Frequently Asked Questions

1. **For vaccines that are recommended by the manufacturer to be given at 3-week intervals, is it appropriate to administer at a 4-week interval for puppies?**

For MLV vaccines, administration at intervals of 4 weeks is acceptable, as long as the final puppy booster is given at 16 weeks of age or older. This is in line with existing international guidelines and scientific evidence. For inactivated or killed vaccines, it is advised to adhere to the intervals recommended by the manufacturer as prolonged intervals may result in inadequate protection. Deviation from manufacturer's guidelines by any veterinarian must be evidence-based and should be discussed with the owner, followed by documentation in the animal's medical records.

2. **For imported puppies that were given a course of "early finish" vaccines at their country of origin, do they still require additional booster vaccines until they reach 16 weeks of age or older?**

It is recommended that the final dose of the initial puppy series be given at 16 weeks of age or older, even if they were given a course of "early finish" vaccines. Based on the current evidence, there are no core vaccines that are able to immunize an acceptable percentage of puppies when the last dose is given at 10 weeks of age (i.e. "early finish") due to interference from MDA[ii,xi]. Puppies that have not received the final dose at 16 weeks of age or older should be kept fully indoors and only with healthy and fully vaccinated dogs to reduce their risk of exposure to pathogens.

3. **Can core and/or non-core vaccines be administered to cats that have tested positive for FIV and/or FeLV?**

Core vaccines may be given to cats with FIV and/or FeLV infection because they can develop more severe clinical disease after natural exposure to the pathogens covered by the core vaccines compared with non-retroviral infected cats. While there is insufficient evidence to suggest that MLV vaccines are a significant risk in cats with FIV and/or FeLV infections, some veterinarians may choose to administer killed vaccines instead out of precaution[ii,xv]. Non-core vaccines may be administered to these cats following a veterinarian's assessment of the risks and benefits for individual cases and following discussion with the owners. FIV and FeLV vaccines must not be administered to cats that test positive for FIV and FeLV respectively.

4. **If a puppy or kitten falls ill during the initial puppy or kitten vaccination series, when can the next booster vaccination be administered?**

The booster vaccination should be delayed until the puppy or kitten is assessed to be clinically well by the veterinarian. The decision of how long after recovery to administer the booster vaccination should be made based on factors such as aetiology and severity of the condition that resulted in the delay and exposure risks to vaccine-preventable diseases, and following discussion with the owners.

5. **If a puppy or kitten comes in late (e.g. lapse of more than 6 weeks from previous vaccination) for a booster vaccination during the initial puppy or kitten vaccination series, do they require additional boosters?**

For MLV vaccines, the puppy or kitten vaccination series can be resumed at the recommended intervals in the guidelines, with the final dose being administered at 16 weeks of age or older without the need for any additional doses after that. For inactivated or killed vaccines, at least two of the doses in the initial series should be administered at the intervals recommended in the guidelines. If this was not achieved, additional boosters of inactivated or killed vaccines may have to be given beyond 16 weeks of age.

6. If a puppy or kitten has already had 2 or 3 vaccinations done by the pet shop or breeder, does it still need any more vaccinations when it is sold and goes to a new home?

For puppies and kittens, the initial series recommended is to vaccinate every 2 to 4 weeks until 16 weeks of age or older. If the puppy or kitten has not been vaccinated according to this series, the protective immunity induced by vaccinations may be inadequate due to interference from MDA[ii]. This puts the puppy or kitten at risk of developing vaccine-preventable diseases, especially if it is exposed to these pathogens, e.g. brought out for walks or to socialise, or brought into a household with other unvaccinated animals. Clinical signs may only be apparent after a period of time (incubation period) has passed, after the puppy or kitten is at its new home. While the new puppy or kitten has not completed this initial vaccination series, it should be kept indoors and away from other unvaccinated animals to reduce the risk of exposure to pathogens.

7. Can a vaccine be administered when the animal is under sedation or general anaesthesia (e.g. for routine sterilisation, fractious animals)?

It is not advisable to administer a vaccine when an animal is under sedation or general anaesthesia. If the animal develops a hypersensitivity reaction and vomits, there is an increased risk of aspiration if it is under sedation or general anaesthesia[ii]. Additionally, anaesthetic agents may be immunomodulatory, affecting the efficacy of vaccination in inducing protective immunity. Administering vaccines under sedation or general anaesthesia should be performed after a veterinarian's assessment of the risks and benefits and following discussion with the owners, with documentation in the medical records of the animal.

8. Is the full dose or volume of a vaccine too strong for a small puppy/kitten or "miniature" and "toy" breeds?

No. The volume recommended by the manufacturer generally represents the minimum immunizing dose, which means that the total amount must be given to induce protective immunity. Unlike medications that are dose-dependent, vaccines are not based on body mass or size, but rather on the minimum immunizing dose[ii]. Reducing vaccine doses should not be practised regardless of size or age of the dog.

9. How long can a vaccine be kept after reconstitution?

It is recommended to discard any unused vaccines 1 to 2 hours after reconstitution, regardless of whether the product has been kept refrigerated or not[ii,xxv].

Acknowledgements

The Singapore Vaccination Guidelines Working Group acknowledges the work of the WSAVA vaccination guidelines group in publishing the WSAVA Guidelines for the Vaccination of Dogs and Cats. We also acknowledge the work and publications of the American Animal Hospital Association (AAHA) Canine Vaccine Task Force, the American Association of Feline Practitioners (AAFP) Feline Vaccine Advisory Panel, the European Advisory Board on Cat Diseases (ABCD), the Veterinary Medicines Directorate (VMD) of the UK and all the authors whose work was referenced for the development of these guidelines.

We would like to thank the Society for the Prevention of Cruelty to Animals (SPCA) of Singapore for sharing their input on the vaccination of dogs and cats in the shelter environment.

References

[i] American Animal Hospital Association, Antibody testing for vaccine-preventable diseases, viewed 1 March 2020, https://www.aaha.org/aaha-guidelines/vaccination-canine-configuration/antibody-testing-versus-vaccination/.

[ii] Day, MJ, Horzinek, MC, Schultz, RD & Squires, RA 2016, 'Guidelines for the vaccination of dogs and cats', Journal of Small Animal Practice, vol. 57, pp. E1-E45.

[iii] Mitchell, KD 2015, 'Canine parvovirus', viewed December 2019, https://www.msdvetmanual.com/digestive-system/diseases-of-the-stomach-and-intestines-in-small-animals/canine-parvovirus.

[iv] Decaro, N & Buonavoglia, C 2012, 'Canine parvovirus-a review of epidemiological and diagnostic aspects, with emphasis on type 2c', *Veterinary Microbiology*, vol. 155, pp. 1-12.

[v] Chiang, SY, Wu, HY, Chiou, MC & Chang, MC 2016, 'Identification of a novel canine parvovirus type 2c in Taiwan', *Virology Journal*, vol. 13, no. 160.

[vi] Xinyu, T, Chong, SM, Wang, Y & Soh, ML 2019, 'Canine parvovirus-2c (CPV-2c) infection in wild Asian palm civets (Paradoxurus hermaphroditus) in Singapore', *Journal of Wildlife Diseases*, vol. 55, no. 4, pp. 000-000.

[vii] Rendon-Marin, S, da Fontoura Budaszewski, R, Canal, CW & Ruiz-Saenz, J 2019, 'Tropism and molecular pathogenesis of canine distemper virus', *Virology Journal*, vol. 16, no. 30.

[viii] Creevy, KE, 'Canine distemper overview', viewed January 2020, https://www.msdvetmanual.com/generalized-conditions/canine-distemper/canine-distemper-overview.

[ix] Sykes, JE 2014, *Canine and Feline Infectious Diseases,* Saunders, Missouri.

[x] Creevy, KE, 'Overview of infectious canine hepatitis', viewed January 2020, https://www.msdvetmanual.com/generalized-conditions/infectious-canine-hepatitis/overview-of-infectious-canine-hepatitis.

[xi] Day, MJ, Karkare, U, Schultz, RD & Squires, R 2014, 'Recommendations on vaccination for Asian small animal practitioners: a report of the WSAVA vaccination guidelines group', *Journal of Small Animal Practice*, vol. 56, pp. 77-95.

[xii] American Veterinary Medical Association, *Canine influenza FAQ*, viewed 1 March 2020, https://www.avma.org/canine-influenza-faq.

[xiii] University of Wisconsin-Madison, School of Veterinary Medicine 2018, *Sanitation in animal shelters*, viewed 15 March 2020, https://www.uwsheltermedicine.com/library/resources/sanitation-in-animal-shelters#List.

[xiv] Greene, C & Sykes, JE 2012, Infectious Diseases of the Dog and Cat, 4th edn, Saunders, Missouri.

[xv] Little, S, Levy, J, Hartmann, K & Hofmann-Lehmann, R 2020, '2020 AAFP feline retrovirus testing and management guidelines', *Journal of Feline Medicine and Surgery*, vol. 22, pp. 5–30.

[xvi] Chan, CT, Beatty, JA, Barrs, VR & Morris, AK 2013, 'Evidence for feline immunodeficiency virus, feline leukaemia virus, bartonella spp, haemoplasmas, and toxoplasma spp. exposure in Singaporean cats', *ACVIM Abstracts*, ID-31.

[xvii] Druce, JD, Robinson, WF, Locarnini, SA & Kyaw-Tanner, MT 1997, 'Transmission of human and feline immunodeficiency viruses via reused suture material', *Journal of Medical Virology*, vol. 53, pp. 13–18.

[xviii] The Center for Food Security and Public Health 2017, *Zoonotic Chlamydiae maintained in mammals*, viewed 15 March 2020, http://www.cfsph.iastate.edu/Factsheets/pdfs/chlamydiosis.pdf.

[xix] Hartley, JC, Stevenson, S, Robinson, AJ & Littlewood, JD 2001, 'Conjunctivitis due to Chlamydophila felis (Chlamydia psitacci feline pneumonitis agent) acquired from a cat: case report with molecular characterization of isolates from the patient and cat', *Journal of Infection*, vol. 43, no. 1, pp. 7-11.

[xx] Kass, PH, Barnes Jr, WG, Spangler, WL & Chomel, BB 1993, 'Epidemiologic evidence for a causal relation between vaccination and fibrosarcoma tumorigenesis in cats', *Journal of the American Veterinary Medical Association*, vol. 203, no. 3, pp. 396-405.

[xxi] Kass, PH, Spangler, WL, Hendrick, MJ & McGill, LD 2003, 'Multicenter case-control study of risk factors associated with development of vaccine-associated sarcomas in cats', *Journal of the American Veterinary Medical Association*, vol. 223, no. 9, pp. 1283-92.

[xxii] Scherk, MA, Ford, RB, Gaskell, RM & Hartmann, K 2013, '2013 AAFP feline vaccination advisory panel report', *Journal of Feline Medicine and Surgery*, vol. 15, pp. 785-808.

[xxiii] Dean, RS, Pfeiffer, DU & Adams, VJ 2013, 'The incidence of feline injection site sarcomas in the United Kingdom', *BMC Veterinary Research*, vol. 9, no. 17.

[xxiv] Gobar, GGM & Kass, PH 2002, 'World wide web-based survey of vaccination practices, postvaccinal reactions, and vaccine-site associated sarcoma in cats', *Journal of the American Veterinary Medical Association*, vol. 220, pp. 1477-1482.
[xxv] American Animal Hospital Association, Vaccine handling and storage, viewed 1 March 2020, https://www.aaha.org/aaha-guidelines/vaccination-canine-configuration/frequently-asked-questions/how-long-can-a-reconstituted-vaccine-remain-unrefrigerated/.