

Council Report

AVMA Council on Biologic and Therapeutic Agents' report on cat and dog vaccines

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The AVMA Council on Biologic and Therapeutic Agents (COBTA) has undertaken a comprehensive review of dog and cat vaccination information. This process included review of the published literature, as well as convening 4 panels of experts to form a consensus on use of canine and feline vaccines. The 4 panels included experts from academic, industry, regulatory, and practice backgrounds.

This report represents the fifth of 6 or more steps in the process of communicating to the profession. Step 1 was a Commentary article prepared by COBTA titled "Vaccination issues of concern to practitioners" published in the April 1, 1999 JAVMA. Step 2 was the open practitioner forum held during the 2000 AVMA Annual Convention in Salt Lake City. Step 3 was the release of the Principles of Vaccination. Step 4 was the redrafting of the AVMA client information brochure titled "What you should know about vaccination."

Vaccine Issues for Practitioners

Almost every veterinary practitioner has experienced the devastating impacts of diseases of dogs and cats that can now be prevented with effective vaccination. Vaccination programs have played an important role in preventing diseases and in fostering early detection and treatment through regular physical examinations during the life of the animal.

Historically, when any doubt existed regarding the need to vaccinate an animal, practitioners usually recommended revaccination. They strove to provide maximum protection for the animal, because the risks associated with vaccination were considered minimal compared with the threat of disease. Veterinarians' experiences with the value of vaccines in preventing disease

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The COBTA wishes to extend special thanks to the numerous experts for their intellectual contributions and their commitment to the profession.

morbidity and mortality, coupled with the inability to quantify risks associated with vaccination, prompted the vaccination rates commonly accepted under the standard of veterinary care until recently.

Vaccination recommendations used to be considered a simple part of animal care, but are now considered complex and controversial. Currently, recommendations tend to reflect what has always been true—vaccination is the complex use of medically powerful agents for which important medical decisions on relative risks and benefits must be individualized to the needs of the animal.

Summary of the Principles of Vaccination

The AVMA, through COBTA and other contributors, has collected valid scientific information on the subject and kept practitioners informed of these findings. Because of these actions, the AVMA Executive Board approved COBTA's Principles of Vaccination in April 2001. Practitioners can find the principles in the September 1, 2001 issue of the JAVMA or on the AVMA Web site (www.avma.org). In addition, a copy of the principles may be requested from the AVMA office.

A few of the take-home messages from this document include:

- ▶ Vaccinations are an important part of preventive medical practices, which in turn are an important part of providing animals with optimal health care.
- ▶ Vaccination is a potent medical procedure associated with benefits and risks for animals. Knowledge of immunology and vaccinology, including associated benefits and risks of vaccine use and the pathobiology of infectious diseases, is necessary to implement an effective individualized vaccination program. Considerations of exposure probability, susceptibility, severity of the disease, efficacy and safety of the vaccine, potential public health concerns, and owner's preferences are appropriate.
- ▶ Individual animals will require different vaccines and vaccination programs. Only those veterinarians with a valid veterinarian-client-patient rela-

tionship are in a position to make appropriate vaccination recommendations.

- ▶ Revaccination recommendations should be designed to create and maintain clinically relevant immunity while minimizing adverse event potential. The practice of revaccinating animals annually is largely based on historic precedent supported by minimal scientific data. There is increasing evidence that some vaccines provide immunity beyond 1 year. Unnecessary stimulation of the immune system does not result in enhanced disease resistance and may expose animals to unnecessary risks.
- ▶ Veterinarians should consider creating a core vaccination program for most of the animals in their practice area. Core vaccines are defined as vaccines appropriate to provide protection in most animals against diseases that pose a risk of severe disease because the pathogens are virulent, highly infectious, and widely distributed in the region. Core vaccines are considered to be highly efficacious, to have benefit-risk ratios high enough to warrant their general use, to be of substantial public health importance, or are required by law.
- ▶ Veterinarians should consider creating a noncore vaccination program designed for the minority of animals in their practice area. Noncore vaccines meet 1 or more of the following conditions: they target diseases that are of limited risk in the geographic region or in the lifestyle of the pet, they help protect against diseases that represent less severe threats to infected animals, their benefit-risk ratios are too low to warrant product use in all circumstances, or inadequate scientific information is available to evaluate them. Veterinarians and owners/clients need to carefully consider the benefits and risks of using noncore vaccine products on an individual basis.
- ▶ Current adverse event reporting systems need substantial improvement in the capture, analysis, and dissemination of information. Practitioner commitment to reporting adverse events and practitioner access to timely analyses of adverse event data are essential to providing optimal animal care.

Concerns about the Principles of Vaccination

By far, the most common criticism of the principles is that they do not tell practitioners how to set up vaccination programs. This is true. The COBTA determined early in its investigation that the creation of suggested vaccination protocols was beyond its scope. The council could not write vaccination protocols that would apply to all species, all animals, in all animal environments, for all geographic regions, or for all veterinarians. Therefore, COBTA strove to write a set of principles that would have universal application for all veterinarians. The council will encourage those allied organizations, through the Clinical Practitioners Advisory Committee, to develop more precise vaccination recommendations applying the principles of vaccination to ensure their recommendations are science based versus a substitute of one arbitrary standard for another.

Current and Future Plans

COBTA has developed a new client education brochure to comply with the principles of vaccination. The brochure includes discussion of vaccination issues and concerns. It is designed to aid practitioners' educational programs for clients by explaining what vaccines are, why vaccines are needed, how vaccines work, and how they are used in a complete preventive medicine program.

COBTA is actively working with allied species groups of the AVMA to encourage science-based, species-specific vaccination information.

COBTA is working with the USDA and the Animal Health Institute (a group representing vaccine manufacturers) to develop a new set of guidelines for labeling vaccines. It is the council's goal to create vaccine labels that accurately identify the product, inform practitioners about what the vaccine contains, adequately describe the data submitted to the USDA to support the stated safety and efficacy of the vaccine, accurately describe pertinent safety issues, and feature claims or use recommendations that are adequately based in science. The council believes duration of immunity claims, which should include considerations of minimum and maximum duration of immunity, are best answered by scientific study and should not be represented by an arbitrary one-size-fits all label.

The council is working with the entire cross section of the animal health industry to redefine how safety and efficacy information from the clinical use of animal health products is gathered, analyzed, and disseminated. An appropriate system might include a set of sentinel practices in various geographic locations. Practices in the network would collect information about infectious diseases in their area and information about animals after they were exposed to, or treated with, medicinal agents. It is COBTA's goal to create a system that will accurately provide to researchers and practitioners clinically relevant information about any threat that is posed by infectious organisms and to collect information about the actual clinical use of medicinal agents in animals.

Vaccines and Vaccine Handling

Vaccine handling, including shipment and storage, is critical to maintaining potency to the expiration date. Vaccines are sensitive to extreme heat or freezing. Every user should have a protocol for immediately checking the condition of vaccines when they arrive, because vaccines that are too warm or too cold may be damaged. If a damaged product is received, veterinarians should immediately record the condition, contact the company, determine that the returned product will be destroyed, and follow the company's instructions for return and replacement.

Development of validated methods for proper handling of vaccines during shipment and storage is needed to ensure the integrity of biologics and the health of animals. Veterinarians are reminded that the refrigerators they use for storage of vaccines should have their temperatures checked regularly using validated methods.

Specific Disease and Vaccine Comments

Comments on diseases are offered for the typical house pet cat and dog and do not consider the special circumstances associated with catteries, kennels, shelters, or households with numerous animals contained in interactive environments. A few comments are included on multiple-cat households with respect to certain diseases; however, readers are cautioned that this review did not focus on the special circumstances associated with high-density animal environments. Kittens and puppies under 16 weeks of age represent the most susceptible age group. They experience the highest rates and most severe cases of disease and are therefore the principal target population for vaccination. Maternal antibody is a substantial impediment to successful immunization against many diseases; therefore, a series of periodically spaced vaccinations is indicated in young animals.

COBTA supports recommendations that administration sites for potential injections in cats be chosen according to the guidelines developed by the American Association of Feline Practitioners and adopted by the Vaccine-Associated Feline Sarcoma Task Force. To further characterize the causal link and to facilitate treatment of vaccine-associated sarcomas, it is recommended that:

- ▶ Vaccines containing antigens limited to feline parvovirus (panleukopenia), herpesvirus type-1, and feline calicivirus (+/- chlamydia) should be administered on the right shoulder.
- ▶ Vaccines containing rabies virus antigen (plus any other antigen) should be administered on the right hind limb as distally as possible.
- ▶ Vaccines containing feline leukemia virus antigen (+/- any other antigen except rabies) should be administered on the left hind limb as distally as possible.

Additionally, veterinarians should document the injection location, vaccine type, manufacturer, and serial number in the medical record. Injection sites of other medications should also be recorded.

Core Vaccines

Vaccines against the following diseases, caused by pathogens that are widely distributed in North America and pose a substantial risk of severe disease in essentially all cats and dogs, should be considered core vaccines.

Core Vaccines for Cats

- ▶ Feline panleukopenia (feline parvovirus infection)
- ▶ Feline viral rhinotracheitis (herpesvirus-1 infection)
- ▶ Feline calicivirus infection
- ▶ Rabies
 - ▶ Rabies is a disease of cats that represents a fatal risk to infected cats and people.
 - ▶ In some areas of North America rabies vaccination of cats is mandatory under state or local laws, and in other areas it is discretionary.
 - ▶ See discussion under section on vaccine use in cats.

Vaccines against feline leukemia virus infection,

which is caused by a viral pathogen widely distributed in North America that may pose a risk of severe disease, should be considered as an additional core vaccine for all cats that live outside full or part time, or those living full time inside but with exposure to outside cats. If recommended, it should target kittens:

- ▶ under 16 weeks of age
- ▶ with a negative FeLV test result
- ▶ with a realistic risk of exposure to the virus.

Core Vaccines for Dogs

- ▶ Canine distemper
- ▶ Canine parvovirus infection
- ▶ Hepatitis (canine adenovirus type 1 infection); COBTA recommends the use of only adenovirus type 2 vaccines, because they provide cross protection against hepatitis and are considered to have substantially lower adverse event potential.
- ▶ Rabies

Noncore Vaccines

The benefits and risks of using vaccine products against the diseases listed in the following section must be carefully considered by veterinarians and owners/clients when 1 or more of the following conditions exist: limited potential for exposure to the disease because of the animal's lifestyle or the nonuniform exposure distribution of the disease in North America, lower virulence of the disease representing less severe illness, vaccine benefit-risk ratios that are insufficient to warrant the use of these products in all circumstances, and a lack of adequate scientific information to evaluate clinical need, efficacy, and safety of the vaccine.

Noncore Vaccines for Cats

- ▶ Chlamydiosis (formerly *Chlamydia psittaci*, now *Chlamydia felis* infection)
- ▶ Feline infectious peritonitis (feline coronavirus infection)
- ▶ Dermatophytosis (*Microsporum canis* infection)
- ▶ Bordetellosis (*Bordetella bronchiseptica* infection)
- ▶ Giardiasis (*Giardia lamblia* infection)
- ▶ Feline immunodeficiency virus infection

Noncore Vaccines for Dogs

- ▶ Canine adenovirus type 2 infection (intended for respiratory disease protection)
- ▶ Canine parainfluenza virus infection
- ▶ Bordetellosis (*Bordetella bronchiseptica* infection)
- ▶ Leptospirosis (*Leptospira canicola*, *L. icterohaemorrhagiae*, *L. pomona*, and *L. grippityphosa* infections)
- ▶ Canine coronavirus infection
- ▶ Borreliosis (Lyme disease)
- ▶ Giardiasis (*Giardia lamblia* infection)

Vaccine Use Issues

One aspect of the decision to use a vaccine in dogs and cats is assessment of the benefits of providing some level of vaccine-induced protection against the disease and the potential risk of adverse events associated with vaccination. Little unbiased information is available to veterinarians on the effectiveness and safe-

ty of vaccines used in clinical practice settings. This lack of information is the result of many factors, but 1 of the more important is an inadequate system for adverse event data capture, analysis, and dissemination. Variations in vaccine products and their administration, the health status of the animal, and the animal's genetic predisposition to adverse events such as vaccine-associated feline sarcoma may all contribute to the adverse event potential. In addition, an animal's immune system response can vary because of factors including their genetic makeup, interference from concurrent medications, stress, parasitism, and other factors. Animals within a population, then, may fail to respond to vaccines in a consistent and predictable pattern.

COBTA has completed a review of peer-reviewed literature and has assembled consensus opinions from a wide spectrum of experts on vaccine use. These comments should be regarded as representative of the best opinions available and the current state of knowledge. It is acknowledged that these opinions are not universally held by all experts, and that there are insufficient data to authoritatively define the benefits and risks of all vaccine products for the practitioner.

Vaccine Use in Cats

Feline panleukopenia—Feline panleukopenia, caused by feline parvovirus, is a potentially severe, life-threatening infectious disease. Inside and outside cats are considered at high risk of exposure, because the virus can survive sufficiently in the environment to be transported on clothing, shoes, and other fomites.

Although vaccine brands may differ substantially, the efficacy of parenteral modified-live and killed virus vaccines is generally considered high. The efficacy of intranasal modified-live panleukopenia vaccines has been questioned. The potential rate and severity of adverse events are considered low to moderate with parenteral products. Caution should be used with some **modified-live virus (MLV)** intranasal products used in kittens under conditions of high density and high stress. Modified-live products have not been shown to be safe in pregnant queens or in kittens less than 1 month old.

Maternal antibody in most kittens decreases to a concentration that allows successful immunization by 12 weeks of age. There is a growing body of evidence that by following a successful kitten vaccination series and revaccinating at 1 year of age, the subsequent revaccination interval can be extended beyond 1 year.

Feline viral rhinotracheitis—Feline viral rhinotracheitis, caused by **feline herpesvirus-1 (FHV-1)**, is considered a potentially severe infectious disease, but most infections result in mild clinical disease and chronically infected carrier states. Risk of exposure is considered high for cats in high-density environments. Husbandry is an extremely important component for controlling this disease.

Maternal antibody generally decreases to a concentration that allows successful immunization by 12

weeks of age. Topical vaccines are capable of stimulating local immunity in the case of high maternal antibody concentrations prior to 12 weeks of age.

Although vaccines differ, the efficacy of modified-live parenteral, modified-live intranasal, and killed parenteral vaccines is considered to be high, but successful vaccination often only decreases the severity of the clinical disease and does not prevent infection or carrier states.

Adverse events include the possibility of creating carrier states with MLV vaccine and signs of clinical disease from mucosal exposure to the MLV parenteral products (licking injection sites). Intranasal MLV products are more attenuated and less likely to cause clinical disease with mucosal exposure than are the parenteral MLV products. Modified-live products have not been shown to be safe in pregnant queens. There is a growing body of evidence that by following a successful kitten vaccination series and revaccinating at 1 year of age, the revaccination interval can be extended beyond 1 year.

In catteries that do not have occurrences of upper respiratory disease, the use of killed vaccines is recommended, because they will limit acute disease and will not introduce the attenuated vaccine virus into the group. If FHV-1 is enzootic, it may be preferable to give MLV intranasal vaccine, because it provides faster immunity and improved local immunity and may be less likely to add to the infection problem than the MLV parenteral product.

Outbreaks of FHV-1 infections spread rapidly, usually affecting all susceptible animals in a colony within 2 weeks. During an outbreak involving only a few sick cats, the use of MLV parenteral or intranasal products seems to provide susceptible individuals with a sub-clinical infection and results in more timely control.

Feline calicivirus infection—Calicivirus infection in cats usually results in mild clinical disease and chronically infected carrier states, although severe clinical disease is sometimes reported. Maternal antibody generally decreases to a concentration that allows for successful immunization by 12 weeks of age. The protection from clinical disease afforded by calicivirus vaccines appears to be variable and greatly influenced by the heterogeneity of the caliciviruses that circulate in the cat population. Calicivirus vaccines may only decrease the severity of the disease and not prevent infection and carrier states. Vaccines that contain similar antigens to the challenge organism generally provide better protection. Duration of immunity studies on a small number of calicivirus challenges with similar antigens suggest that, by following a successful kitten vaccination series and revaccinating at 1 year, the revaccination interval can be extended beyond 1 year. The duration of immunity when vaccines and challenge antigens are dissimilar has not been well studied.

Adverse event rates appear to be higher for the modified-live calicivirus products and include carrier states with clinical signs. Avoid mucosal exposure to the MLV parenteral products (licking injection sites) as signs of disease may result. Modified-live products have not been determined to be safe in pregnant queens.

The impact of low-level or mild disease rates between vaccinates and nonvaccinates appears low, but the use of MLV products may increase the carrier rates in households with numerous cats. Killed vaccines do not result in carrier states, and they prevent acute signs of the disease.

Rabies—Rabies virus represents a fatal risk to infected cats and people. In some areas of North America rabies vaccination of cats is mandatory due to state or local law, and in other areas it is discretionary. COBTA recognizes that various regions of the United States have different vectors and host-adapted rabies strains resulting in different risk issues for cats. COBTA is encouraging the necessary discussions to re-evaluate the relative risks and benefits of vaccination to cats, including any potential public health impacts associated with discretionary vaccination against this disease in regions with low risks. The AVMA Council on Public Health continues to support mandatory rabies vaccination for all cats in North America.

Unlike many other previously licensed biologics, rabies vaccines are tested to determine their minimum duration of immunity. Local and regional regulatory authorities mandate revaccination schedules including some that are more frequent than necessary as demonstrated by scientific evidence.

Feline leukemia—Feline leukemia is a potentially severe life-threatening infectious disease caused by the virus that bears the name of the disease; however, risk of exposure is considered high only for those kittens that come into close contact with viremic carrier cats, such as kittens that live portions of their lives outside, and those maintained in high-density feline environments with viremic carriers. The younger the kitten is at exposure, the greater its chance of becoming permanently infected. Susceptibility decreases with age, and kittens older than 16 weeks appear to be resistant to infection on the basis of laboratory-based challenge studies. Vaccines are labeled for use in kittens 9 weeks and older. It has been difficult to experimentally infect cats older than 1 year without first having severely depressed the immune system. Most older cats that become infected will recover and not become chronic carriers. Control of FeLV in controlled management conditions is best accomplished by testing and elimination of carriers.

Laboratory-based comparisons of the efficacy of various FeLV vaccines have been highly variable, and efficacy has been affected by the challenge models and genetic background of the cats tested. Preventing exposure remains an important control strategy. Veterinarians should carefully select the brands of vaccine they use on the basis of scientific evidence.

Screening prevaccinates by ELISA and use of the indirect immunofluorescent antibody test to confirm infection in cats are the recommended testing methods. There is no known benefit to vaccinating cats infected with FeLV.

Vaccination is not recommended for cats with minimal to no risk of exposure, especially after 4 months of age. If vaccination is deemed appropriate because of a high-risk environment, most experts recommend annual revaccination because of the difficulty in assessing age-related resistance status.

Chlamydiosis—*Chlamydia felis*, formerly known as *Chlamydia psittaci*, causes chlamydiosis and has variable virulence. A high risk of infection exists in situations of high animal density and poor husbandry. The efficacy of the vaccines in preventing disease or carrier states is considered poor, and even though studies have demonstrated the ability of vaccines to lower the severity of an infection, the degree of improvement provided through vaccination is highly variable. Published references indicate a 1-year duration of immunity, but most experts believe the duration of immunity is considerably shorter.

Chlamydia felis vaccines appear to be more likely to cause transitory fever and lethargy than other feline vaccines. In addition, there appears to be more likelihood of *Chlamydia felis* vaccine involvement in mild respiratory disease.

Vaccination is not recommended for cats with minimal or no risk of exposure. If vaccination is deemed appropriate, annual revaccination appears reasonable. In many management situations, control is better achieved by hygiene and the control of other upper respiratory infections. Antimicrobials are effective in controlling the clinical illness.

Feline infectious peritonitis—Feline coronavirus causes feline infectious peritonitis. The vaccine has not been demonstrated to induce immunity in kittens younger than 16 weeks old, and previous exposure to feline enteric coronavirus usually results in neutralization of the MLV vaccine. Kittens in shelters and catteries are considered to be at high risk but not likely to benefit from vaccination, because enteric coronavirus infection is enzootic in those kittens between 6 and 10 weeks of age.

Dermatophytosis—Prevention and control of *M canis* infection is complex in cats, especially in multiple-cat households. The use of an integrated, multifaceted treatment program is usually indicated. There are insufficient published data to comment on the vaccine's clinical role in a control program. The vaccine has not been demonstrated either to reduce the prevalence of infection or to provide culture-negative cures.

Bordetellosis—Efficacy of the vaccine is considered low, and the duration of immunity is considered short. Thus, the clinical value of this vaccine is questionable. Deaths in litters from this disease have been reported to occur prior to the approved age claim for the use of the vaccine. There are no data on the use of the vaccine in younger cats. Some experts expressed concern about the potential for adverse events associated with vaccination of very young cats. Older cats have milder disease signs than dogs and may not benefit substantially from vaccination.

Giardiasis—Insufficient information exists to comment.

Feline immunodeficiency virus infection—A vaccine against FIV was introduced into the marketplace after the COBTA completed this report. During the council's deliberations, neither published literature nor expert panels assembled by COBTA addressed FIV vac-

cination in depth. This new product is a whole-virus killed adjuvant vaccine. Its USDA approved claim is "as an aid in the prevention of infection with feline immunodeficiency virus." An issue for practitioners to consider in the use of this product is that vaccinated cats will become seropositive, as determined by the currently commercially available antibody-based diagnostic tests. This may complicate existing testing guidelines and disease control strategies.

Vaccine Use in Dogs

Canine distemper—Canine distemper is a potentially severe, life-threatening infectious disease with a high risk of exposure. Maternal antibody generally decreases to a concentration that allows successful immunization by 12 weeks of age.

Although vaccines differ, the efficacy of modified-live and recombinant parenteral vaccines is considered high. The adverse event rate and severity potential appear to be low, but includes postvaccinal encephalitis with some vaccines. Some data indicate duration of immunity might be variable; there is a growing body of evidence that, by following a puppy series and revaccinating at 1 year, the subsequent revaccination interval can be extended beyond 1 year. The recombinant product provides protection to 1 year, but there is insufficient experience to predict whether the revaccination interval can be extended.

Modified-live virus vaccines are very temperature sensitive and must be stored within product specifications, prior to and following reconstitution, to ensure potency.

Measles vaccine—The measles vaccine has some indications for use in high-risk distemper environments as a single IM injection in puppies between 4 and 10 weeks of age where there is likely maternal antibody to distemper. The modified-live parenteral product is highly efficacious in protecting from disease but not infection. Adverse events are believed to be infrequent. Vaccination of female puppies beyond 10 weeks of age results in persistent antibody concentrations, which would be transferred to future litters. These antibodies could interfere with response to the measles vaccine should it be indicated for those litters. Early puppy vaccination for measles should be followed by canine distemper vaccination.

Canine parvovirus infection—Canine parvovirus causes a potentially severe life-threatening infectious disease in dogs with a high risk of exposure. Maternal antibody generally decreases to a concentration that allows successful immunization by 12 weeks of age. Protection only occurs when puppies are vaccinated after maternal antibody concentration is sufficiently low to allow primary immunization. Because it takes about 2 weeks beyond the successful administration of the vaccine for a puppy to adequately build protection, this period represents a window of vulnerability.

The efficacy of modified-live parenteral vaccine is considered high. Because there are only small differences between the 2, 2a, 2b, and 2c strains of the virus, vaccines labeled to protect against 1 strain are expect-

ed to protect against all 4 strains. Adverse event rates and severity are considered low. Duration of immunity can vary considerably between products. There is increasing evidence that, by following a puppy series and revaccinating at 1 year, the subsequent revaccination interval can be extended beyond 1 year. Neither mink enteritis nor heterotypic feline panleukopenia virus vaccines are recommended for use in dogs.

Hepatitis—Hepatitis, caused by canine adenovirus type 1 (CAV-1), is a potentially severe, life-threatening infectious disease with a high risk of exposure; however, most infections do not result in severe disease. Maternal antibody generally decreases to a concentration that allows successful immunization by 12 weeks of age.

Protection for CAV-1 disease is obtained from the cross-protection associated with CAV-2 vaccines. Because CAV-2 vaccines have been shown to have less potential for adverse responses, only those vaccines containing CAV-2 are recommended for use. Veterinarians are advised to look carefully at their vaccines to identify whether they include CAV-1 or CAV-2 antigens. Vaccines differ, but the efficacy of modified-live CAV-2 parenteral vaccines is considered high. Adverse event rate and severity potential appears to be low for CAV-2 products. Duration of immunity against hepatitis is considered long. There is increasing evidence that by following a puppy series and revaccinating at 1 year, the revaccination interval can be extended beyond 1 year.

Rabies—The rabies virus represents a fatal risk to infected dogs and people. Rabies in dogs has high potential for spreading to other dogs and is associated with high risks of human exposure because of the infected dog's aggressive behavior, frequent biting, and human interaction. Rabies vaccine is recommended as a core vaccine in all dogs.

The efficacy of rabies vaccines is high. Adverse event rates are considered low to moderate, with low-to-moderate severity. Unlike many other previously licensed biologics, rabies vaccines are tested to determine their minimum duration of immunity. Local and regional regulatory differences impact the required revaccination intervals. Dogs would benefit if the differences in required revaccination schedules between regions were uniform and based on scientific data.

Canine adenovirus type 2 infection—Infection with CAV-2 can lead to respiratory tract disease and may be 1 of many components of infectious tracheobronchitis or kennel cough. Parenteral vaccines have been demonstrated to provide long-term immunity against CAV-1 infection, but expert opinions differ as to their ability to provide long-term protection against the respiratory form (CAV-2). Modified-live intranasal vaccine containing CAV-2 are now available, but their efficacy in preventing clinical infectious tracheobronchitis has not yet been adequately studied. The adverse events associated with these vaccines appear to be minimal. Duration of immunity for the respiratory disease appears to be short. Therefore, if vaccination against the respiratory form

is warranted, annual or more frequent revaccination may be necessary.

Canine parainfluenza—While the risk of exposure to the canine parainfluenza virus is considered to be high, the virulence of this virus is low. Vaccination is recommended only for dogs exposed to kennels, shelters, and shows, and for dogs in large colonies or breeding establishments.

The efficacy of modified-live intranasal vaccines is considered moderate, and that of parenteral MLV vaccine is considered low. Maternal antibody does not interfere with immunity developed from MLV intranasal vaccine.

Adverse event rates are low, and duration of immunity is considered moderate. Resistance to the natural disease develops with age. If vaccination is deemed warranted, annual or more frequent revaccination may be necessary.

Bordetellosis—The risk of exposure to the causative agent is considered to be high in kennel, shelter, show, and breeder groups, but virulence of the organism is low. The efficacy of modified-live intranasal vaccines is considered to be moderate, whereas that of parenteral vaccines is considered low. Adverse event rates are low and include coughing, and duration of immunity is considered short.

Although routine vaccination is not indicated, the use of an intranasal MLV product about 2 weeks prior to exposure appears to have beneficial results.

Leptospirosis—The risk of exposure to various *Leptospira* serovars is regional, generally seasonal, and impacted by the animal's lifestyle or purpose. Virulence of the organism may be high, and the pathogen is zoonotic. The efficacy of the bacterin is variable. A high percentage of animals (perhaps 30%) may not respond to vaccination. The efficacy in those that do respond is generally good. Possible vaccine variation between manufacturers is not known. Adverse event rates are high and can be severe. The duration of immunity is considered short.

Because there is no substantial cross protection between various *Leptospira* serovars, new vaccines that contain those serovars most likely to cause disease in dogs are needed.

Canine coronavirus infection—The risk of exposure to canine coronavirus is considered to be high in kennel, shelter, show, and breeder dogs; however, virulence of the virus is low. The efficacy of vaccines is considered low. Adverse event rates are low. The duration of immunity is considered short.

Borreliosis (Lyme disease)—The risk of exposure to the causative agent is considered to be low except in a few geographic locations with variable virulence of the agent. Even in areas of high exposure, the inci-

dence of disease is low. The efficacy of the vaccine is believed to be limited to previously unexposed dogs (ie, dogs without natural exposure to ticks infected with *Borrelia burgdorferi*). Experts disagree whether the vaccine is clinically effective. There is considerable speculation about the potential of these vaccines to be involved in adverse events. Adverse event rates are considered moderate. If vaccination is used, annual revaccination is recommended.

Giardiasis—Insufficient information exists to comment.

Serologic Tests

COBTA's review did not focus on serologic testing per se, but the council did conclude that it is currently impossible to determine the immune status of an animal relative to all the infectious diseases of concern without conducting challenge testing. Further, serologic results do not appear to be a sensitive indicator of immune response for some diseases or vaccines in cats and dogs. It was concluded that there are variations within and among laboratories, as well as a lack of validated sensitivity, specificity, and confidence intervals, leading to the conclusion that serologic testing is generally unreliable. It is noted that USDA licensing of serologic tests does not require validation of this type.

COBTA agrees that higher serologic titers are generally associated with greater resistance, but acknowledges it is possible for an animal with no titer for a specific organism to have solid resistance to challenge. Conversely, an animal with a titer that is generally regarded as protective for a specific organism may also become ill as the result of challenge, possibly because of overwhelming exposure or immune suppression.

Advances are being made in serologic testing methods, but practitioners are cautioned to consider carefully whether the test proposed has been appropriately validated, thereby providing a predictive value for whether the animal needs to be revaccinated, and includes confidence intervals to help the practitioner determine the risks and benefits of relying on the test results. Practitioners should also determine whether a selected laboratory has a quality control program sufficient to make the test results reliable.

Seeking More Practitioner Input

The AVMA wants to continue to provide vaccine information that practitioners can use. Please share your ideas with any member of the council. Members are listed on pages 1 and 2 of the AVMA 2002 Directory and Resource Manual, or they can be contacted through our AVMA staff liaison, Dr. Elizabeth Curry-Galvin, who can be reached at AVMA headquarters or by e-mail (egalvin@avma.org).