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EDITORIAL

The concept of preventative medicine can sometimes be viewed - at least by the uninitiated - as the poor relation amongst healthcare professions: mainstream specialities such as cardiology, neurology and ophthalmology, with their endless pathologies, multiple presentations and complex diagnostic instruments, coupled with the thrill of curing a patient, may be considered to have a much more immediate appeal. And it is undeniable that for many centuries both human and animal physicians were preoccupied with reacting to ailments and attempting to subdue them; they had little time to consider how they might get ahead of the game, but gradually the clearest thinkers, those who had the ability to look beyond the immediate disease problem, started to consider how prophylaxis could be better than cure. This eventually led to preventative medicine becoming a science - and indeed a speciality - in its own right, so that now the discipline brings immense and far-reaching benefits both to the individual and the wider community.

There are of course many strands to preventative medicine – factors such as diet, vaccination and daily lifestyle all play a part - but knowledge is only one part; delivery, through successful implementation, is the other half of the equation. And as with most things, there are no simple answers or universal solutions; one size does not fit all, whether that is because of geographic, demographic, genetic or individual variations. Anticipation, adaptability and background information are all essential, along with the ability to communicate clearly and offer convincing and constructive advice to owners, for preventative medicine to achieve its ultimate goal. And so the clinician may find that this issue of *Veterinary Focus* is slightly different from the typical format, but the end result should be the same - better knowledge for the veterinarian and better health for our patients.

Ewan McNeill
Editor-in-Chief

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Nutritional considerations for optimal puppy growth

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Denise Elliott graduated from the University of Melbourne in 1991. After completing an internship at the University of Pennsylvania she moved to the University of California-Davis where she completed a residency in Small Animal Medicine, a fellowship in Renal Medicine and Hemodialysis, and a residency in Small Animal Clinical Nutrition. Board certified with both the American College of Veterinary Internal Medicine and the American College of Veterinary Nutrition, she was awarded her PhD in Nutrition in 2001. She has co-authored more than 50 scientific publications and textbook chapters as well as being co-editor of two textbooks. Denise has recently been appointed Global Head of Research at the Waltham Centre for Pet Nutrition.

KEY POINTS

- A puppy's nutritional requirements vary depending on the animal's breed and must be tailored to an individual's specific needs.
- Overfeeding large and giant breed puppies will not produce larger, taller adults, but rather increase the risk of growth disorders.
- High protein diets fed to large and giant breed puppies do not cause osteoarticular disorders.
- Calcium deficiencies and excesses can lead to bone disorders, and calcium supplementation is not recommended.
- Puppies should be weighed once a week, and the amount fed adjusted to maintain ideal body condition.

Introduction

Dogs are a unique species in the animal kingdom, not least because of their hugely variable bodyweight, from the Chihuahua weighing < 1 kg to the Saint Bernard that is more than 80 kg. In association to this large diversity, the rates and duration of growth vary. A small breed dog (adult weight < 10 kg) will multiply its birth weight around 20 times, reach half its adult weight at 3 months, and complete its growth by 10 months of age. The growth period for small breeds is specifically short and intense. Conversely, by one year of age, a large breed dog (adult weight 25 kg or more) will multiply its birth weight at least 70 times; it will reach half its adult body weight around 5-6 months and the growth period may last up to two years.

Small and medium breed puppies gain 20g-60g per day with maximum daily weight increase seen around the post-weaning stage (*i.e.* 2-3 months). Conversely, maximum daily weight gain is generally reached around 3-4 months in large breed puppies and between 4-5 months in giant breeds. Daily weight gain in large and giant breed puppies remains high until 8 months and the weight of these breeds therefore increases considerably over a long period of time. One consequence of the differences in growth is that at weaning the growth of the bone tissue in a small breed is well advanced, whereas it has hardly started in a large or giant breed puppy. These differences in growth rates explain why large and giant breeds have a greater risk of disorders associated with growth and highlight the fact that the requirements of puppies of different breeds are not the same and must be tailored to specific needs.

Energy

Energy requirements for growth will vary depending on the age, sex, breed and environment of the puppy. During the first half of its growth, a puppy requires twice as much energy as an adult dog (in relation to its weight) (1). This increased requirement reflects the extra calories needed to support growth and retention of new tissues. The degree of increase depends on the rate and stage of growth. Younger puppies need more calories per unit of bodyweight than older ones, and large or giant breed puppies require more energy until an older age than puppies of small breeds. This very high requirement gradually decreases; by the time the puppy reaches 80% of its adult weight (*i.e.* at ~ 6 months for a small dog and 8-10 months for a large dog), it consumes only 20% more energy than an adult.

Females are generally lighter than males and reach their maximum growth rate earlier. This sexual dimorphism is much more pronounced in large and giant breeds than in small breeds and is important because it implies differences in requirements at the end of growth between the two sexes. Males have a longer growth period, and therefore have higher energy requirements over a longer period of time.

The exact caloric requirements, and thus amounts to feed, are extremely difficult to estimate in puppies because of wide variations even within a breed. Some recommendations based on the adult body weight have been published (2) but estimation of final adult bodyweight is difficult. Therefore growth curves should be considered as a guideline only, and the amount fed should be adjusted to maintain puppies in ideal to lean body condition. During the rapid growth period (2-8 months of age) it has been recommended that large breed dogs should not gain more than 100 g/day and giant breeds (> 35 kg) not more than 200 g/day. Another recommendation is that at 6 months of age puppies should weigh less than 60% of their adult body weight.

Skeletal abnormalities such as hip dysplasia, osteochondritis dissecans, radius curvus, stunted growth, and hypertrophic osteodystrophy are commonly associated with the growth of large and giant breeds, but quite rare in small breeds (3). While the clinical behavior and the radiological features of these diseases have been clearly defined, little is known of their causes. Genetics has been shown to be a major component, but environmental factors such as nutrition and exercise clearly play a role, and may indeed affect the expression of undesirable genes. Nutrient excesses (particularly energy and calcium), rapid growth rates and excessive weight gain appear to be important factors contributing to the incidence of skeletal disorders.

It is important to note that some owners of large and giant breed puppies mistakenly overfeed their puppies on the underlying assumption that they will foster a larger and taller adult dog. This is simply not true; size is actually determined by the individual's genetics, and overfed puppies will simply grow faster and reach their adult size earlier, with an increased danger of disorders associated with growth. Accelerated growth rates place more strain on an immature skeleton, which significantly increases risks for bone and joint diseases.

Growth rate is indeed directly influenced by energy supply, but a maximal rate of growth is not compatible with optimum growth. Studies have highlighted the damaging effect of excessive energy supply on the growth of large breed puppies. Various groups have looked at the influence of excess energy on skeletal development and found that great Danes fed *ad lib* had a higher frequency of osteoarticular disorders compared to the same breed fed 66% of the *ad lib* ration (3,4). One study monitored growth (from 4 weeks to 6 months) in two groups of great Danes, one fed *ad lib* and the other with a restricted ration (70-80% of the ration); the latter group was itself divided into two, one group being composed of puppies bearing weight loads (15% of their body weight) by means of a belt filled with sand, and the other without weights. After 6 months, the puppies fed *ad lib* all had skeletal problems, as did the load-bearing puppies (5), thus demonstrating the adverse effect of excess weight during growth. A separate study that followed Labradors from 8 weeks to 2 years of age found that dogs fed 75% of the *ad lib* intake of matched littermates resulted in a significant decrease in the radiological and clinical signs of hip dysplasia (6).

Practically, food intake of large and giant breed puppies should be closely controlled during growth. Puppies between 12-16 weeks of age should be fed three to four times a day, reducing to twice daily by 8-10 months old. In order to control growth rate, the puppies should be weighed weekly, and the amount fed adjusted accordingly to maintain lean to ideal body condition.

Protein

Protein requirements are higher for growth than for maintenance. Quality as well as quantity is important to provide the right balance of amino-acids necessary for the harmonious development and function of all body systems. Following the results of a 1970's study (3) some authors inappropriately concluded that a high protein content in food was unfavorable for correct growth of large breed dogs (3,7). This controversial conclusion quickly became a widespread myth that led many breeders, owners, and veterinarians to recommend limiting dietary protein for large breed puppies. This myth has not been supported by scientific or clinical evidence; one study found no difference in the skeletal development of great Dane puppies raised on diets with the same energy content but containing different protein concentrations (8).

Furthermore, an epidemiological study to identify the risk factors associated with osteochondritis dissecans indicated that so-called "premium" foods that are higher in protein seem to have a protective effect (9). These observations collectively indicate that protein cannot be implicated as a cause of osteo-articular problems in large and giant breed puppies.

Calcium and phosphate

Calcium is involved in many body functions, including coagulation, enzyme activation, regulation of endocrine hormone secretions, cardiac function, and control of neuro-muscular excitability. More than 99% of the body's calcium is found in bone, in the form of hydroxyapatite and calcium carbonate within a protein matrix. This mineral structure contributes to the integrity of the skeleton in its supporting role. Both calcium deficiency and excess, in conjunction with the calcium: phosphate ratio, can lead to bone disorders during growth.

A deficiency of calcium in the diet results in nutritional secondary hyperparathyroidism and calcium cation when dogs are fed meat-only diets that are high in phosphate and low in total calcium concentration; one study reported that diets containing insufficient levels of calcium can lead to spontaneous fractures in growing great Danes fed *ad lib* (10).

Excessive calcium intake has been shown to inhibit bone and joint remodeling during growth, thus preventing normal bone and joint formation (8, 11). In great Dane puppies, researchers have demonstrated that a concentration of calcium as 3.3% dry matter (DM) basis was associated with an increased prevalence of radius curvus syndrome, osteochondrosis (OCD), retained cartilage core and stunted growth when compared to a diet containing 1.1% calcium (11). These osteochondrodystrophy lesions appeared at major load-bearing sites such as the proximal and distal ends of the humerus, radius, ulna and tibia, and also in sites where weight has no influence, such as in the ribs.

Small and large growing dogs are not comparable in terms of calcium tolerance. One report showed that in the miniature poodle, calcium concentrations that varied between 0.33% and 3.3%/kg DM provided apparently normal bone growth when compared to control dogs receiving 1.1% calcium (12). Nevertheless, a food with a high calcium concentration led to histological lesions in growing dogs of small breeds (from 2-6 months), but without any clinical signs of osteochondrosis (12). Collectively, these studies have shown that large and giant breed puppies have special requirements compared to small breed puppies.

Young puppies absorb calcium both passively and actively in their intestines. They are incapable of effectively protecting themselves against excess dietary calcium since at least 45-50% of intestinal calcium is absorbed regardless of the quantity ingested (10). Diets rich in calcium therefore lead to chronic excessive absorption of this mineral in the puppy. This excess calcium then stimulates the production of calcitonin, which decreases the blood calcium concentration in order to re-establish normocalcemia. It is through this hormone that calcium produces its adverse effects for growth. The role of calcitonin is in fact to favor the deposition of calcium in the bone tissue and to slow resorption of calcium from the bone. However, in the growing period, the bone tissue is continuously turning over, so that

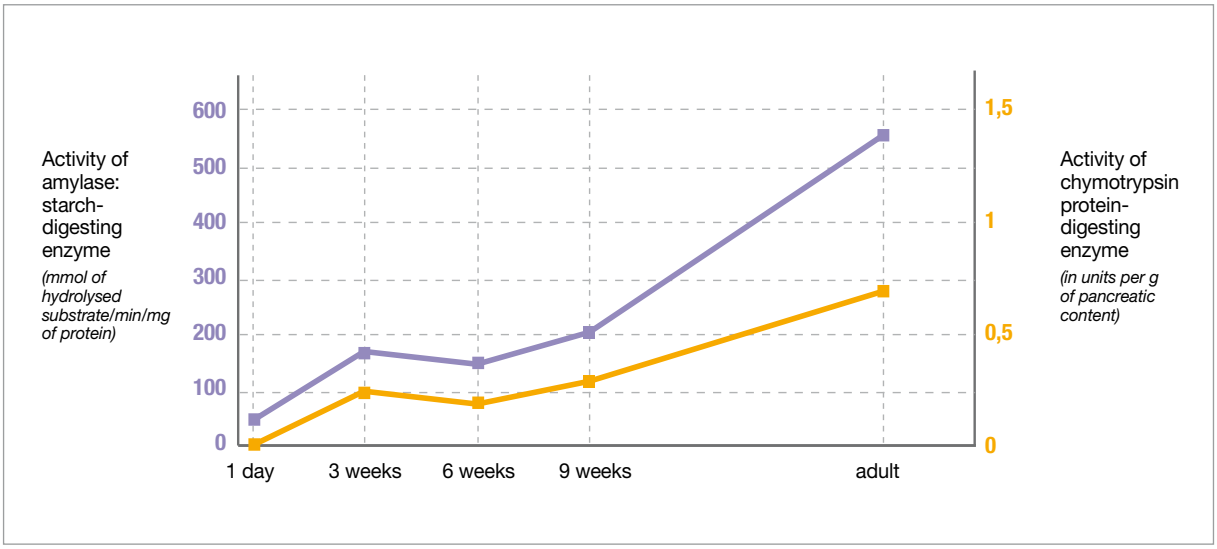

Figure 1. Development of the enzyme capacities of puppies (24).

there are considerable exchanges of calcium between bone and blood. These exchanges are slowed by the action of calcitonin, which results in inhibition of bone tissue remodeling, leading to abnormal bone structure and to osteoarticular deformations.

Vitamins and minerals

Although dietary requirements of trace elements and vitamins are higher during growth, there is no need to supplement commercial puppy diets with these nutrients. Moreover, some trace elements and vitamins including vitamin A, vitamin D and iodine may be toxic if supplemented excessively. In addition, supplementation with some trace elements (*e.g.* zinc) may interfere with the absorption of others - such as copper - and thereby induce secondary deficiencies.

A number of anecdotal accounts, mostly poorly regulated or uncontrolled clinical studies, have suggested supplementation with vitamin C could help in the prevention and treatment of hip dysplasia, osteochondrosis and panosteitis (13). However, there is no adequate scientific evidence to recommend routine vitamin C supplementation to prevent skeletal problems in growing dogs (1). It is well established that the dog is capable of synthesizing all the vitamin C that it needs in its liver. Moreover, large doses of vitamin C (1200 mg per puppy daily) have been shown to aggravate orthopedic problems in Labrador puppies (7,14). These observations show that vitamin C has no beneficial effect on the skeleton of puppies and excessive supplementation is contraindicated.

Digestive security

The puppy's gastrointestinal tract undergoes a period of intensive growth starting in the very first hours after birth and continuing well beyond weaning. Lactase and enterokinase are especially active during the suckling period, whereas the activity of trypsin, chymotrypsin, and aminopeptidase progressively increases throughout growth ***(Figure 1)***. The activity of enzymes such as pancreatic amylase, some peptidases, maltase, sucrase and trehalase only increases after weaning. All of these enzyme changes have profound repercussions on the digestion of carbohydrates and proteins.

Puppies also have shorter gastric evacuation times and higher intestinal permeability than adult dogs (15,16). Size also has a significant influence on gastrointestinal function and should be considered in the selection of an appropriate diet for growth. Several studies have reported that when fed the same diet, large-breed dogs have a lower digestive tolerance than small-breed dogs (15-20).

These differences appear to be linked to anatomical differences: the gastrointestinal tract of a giant breed

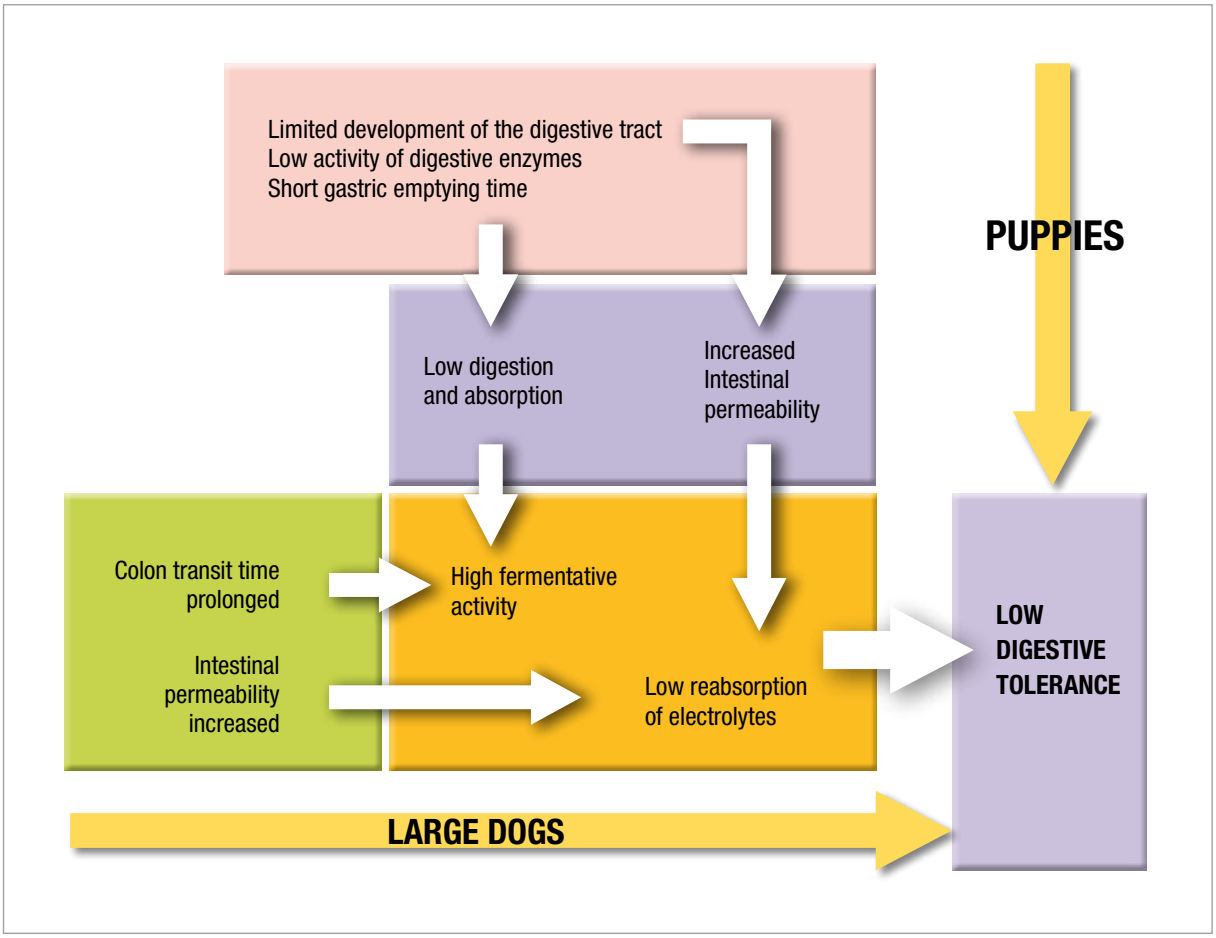

Figure 2. Gastrointestinal factors that contribute to low digestive tolerance in puppies.

dog is proportionally smaller (2.8% bodyweight) than that of a small breed dog (7% bodyweight) (21), whereas the volume of the colon is 40 times larger (22). Studies comparing the digestive function of dogs of various sizes (miniature poodles, standard schnauzers, giant schnauzers and great Danes) showed that the overall ability to digest nutrients, the absorptive capacity of the small intestine, gastric emptying, and intestinal transit did not differ between dogs (15,16,18-20). However, a low overall absorption of electrolytes (possibly due to the increased permeability of the small intestine) and strong fermentative activity (from a particularly long colon transit time) are two significant differences that may explain the low quality of stools in large breeds.

Stress can also be a factor in explaining poor stool quality, especially in breeds of dogs in a constant state of alertness *e.g.* the German shepherd or hyperactive/highly energetic breeds such as the boxer, greyhound etc. Growth is also a period of learning and immense exploration. Collectively, all these challenges, and the physiological changes seen in the developing gastrointestinal system, may explain the higher likelihood for puppies to have soft stools and episodes of diarrhea ***(Figure 2)***. Therefore it is important that diets for puppies are not only designed to optimize growth, but also to facilitate optimal digestion and support of the gastrointestinal system.

Immunity gap

Throughout growth, a puppy gradually loses the protective immunity received via the dam's colostrum. During this time it also develops its own immune defenses from contact with the environment and (especially) from appropriate and timely vaccination. However within this period a window of vulnera-

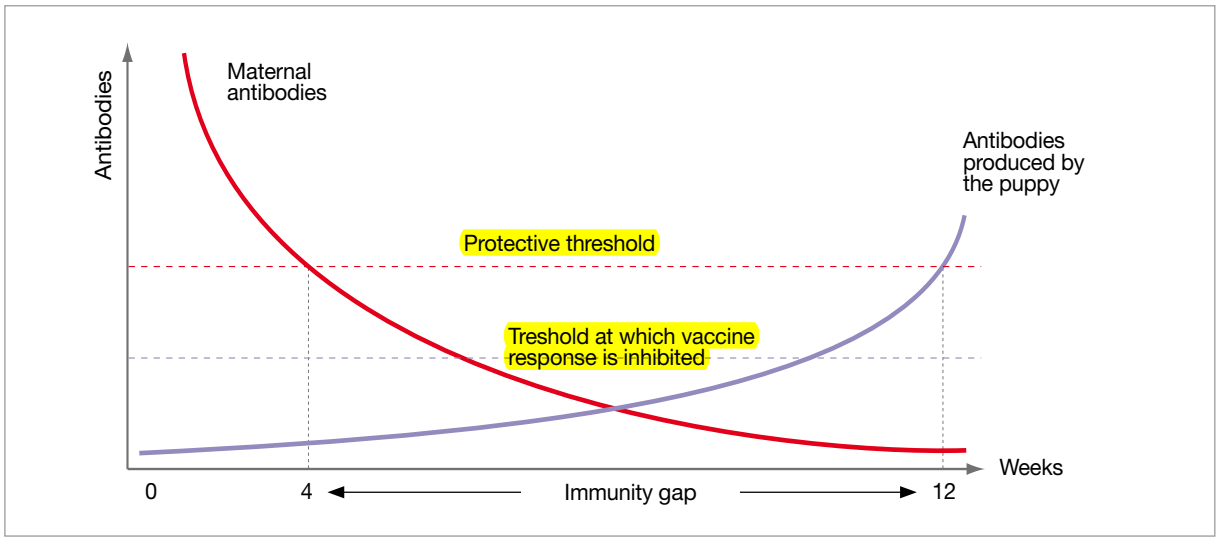

Figure 3. After approximately 4 weeks of age, a puppy's level of maternal antibodies drop below the protective threshold, even though the puppy's own defenses are not yet fully developed. Despite this, the maternal antibodies present until approximately 6-7 weeks of age are enough to inhibit vaccines from working. The period between the point at which maternal antibodies do not confer protection until the time that vaccination produces a protective level of immunity is called the *Immunity Gap*.

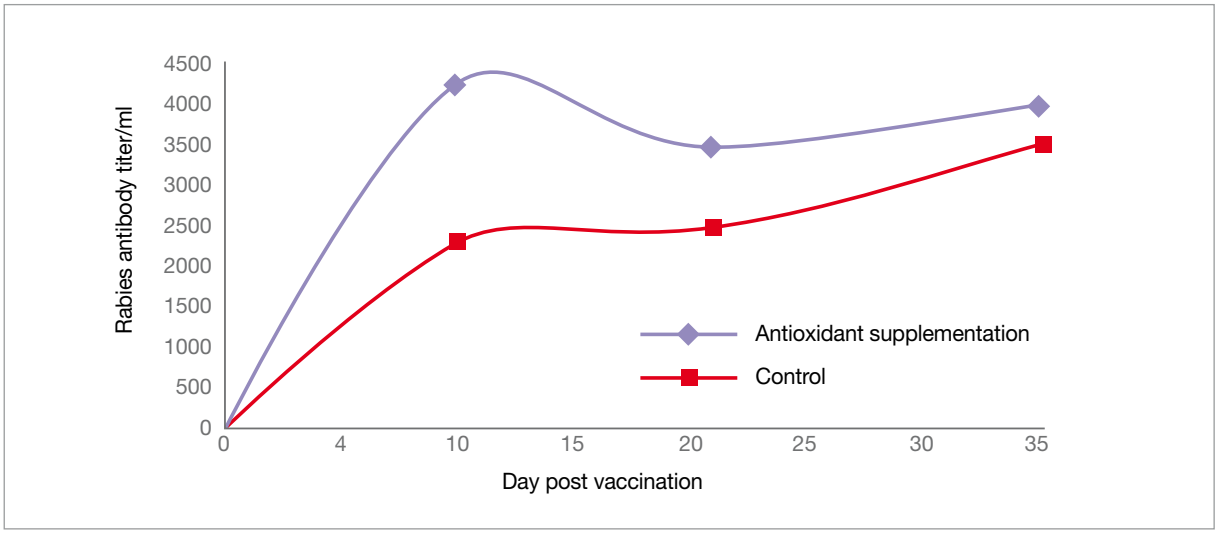

Figure 4. The impact on antibody production following the administration of an antioxidant cocktail for 2 months prior to rabies vaccination in puppies. The immune response recorded was significantly different to that of the control group; the serum antibody count was higher and the protective level was reached more quickly after vaccination (23).

bility exists where the puppy's own immune system has not yet developed adequate protection but levels of maternal antibodies have declined below protection thresholds ***(Figure 3)***. For optimal health this period of vulnerability needs to be minimized. Studies have clearly shown that supplementing the diet with a synergistic combination of antioxidants (vitamin C, vitamin E, taurine, lutein) can significantly increase the levels of serum antibodies, and protective levels are attained more rapidly following vaccination ***(Figure 4)*** (23). This illustrates a role for antioxidants in optimizing the response to vaccination and protection from life-threatening preventable infectious diseases, and therefore puppies should receive a growth diet supplemented with antioxidants.

Conclusion

Growth is a challenging and constantly changing period for the puppy and the nutritional needs differ based on the individual's age, sex, size and breed. Providing a complete and balanced diet that is specifically designed to support a puppy's unique needs is critical for optimal growth and prevention of disorders associated with growth. The key to successful growth is to monitor food intake and constantly adjust the amount fed to maintain ideal body condition.

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Parasite control

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Introduction

The ability to intelligently apply the principles of preventative medicine to parasite control is one of the most important means for the veterinary profession to contribute to world health while maintaining the human-animal bond. Veterinarians are arguably the most highly educated health professionals in the world in the study of parasitology. Since parasites cause a very wide spectrum of diseases in our pets, consideration of the topic cannot easily be lumped into a single discussion. Signs that are sometimes of parasitic origin include vomiting, diarrhea, pulmonary distress and cardiac disease, as well as skin problems such as flea allergic dermatitis and mange, to name but a few. The complexity and diversity of parasites and their varied impact on animal health makes the consideration of parasitology challenging under any circumstances. It is the job of the veterinary practitioner to simplify this discussion so that clients may understand the consequences of uncontrolled infection for their pets as well as their families.

KEY POINTS

- Application of preventative medicine principles to parasite control is one of the most important means for the veterinary profession to contribute to world health.
- The geographical spread of parasites and vectors is a challenge; clinicians must adapt to changing situations.
- The threat of zoonoses emphasizes the need for consistent prevention of parasite diseases in companion animals, not just their treatment.
- A team approach which ensures consistent advice is essential to encourage good owner compliance.

Changing disease patterns

Parasites vary in incidence regionally, with some parasites being found in areas where they did not exist previously. Since many pets are purchased or "rescued" from regions that are often distant from their new homes, each new animal in a household may join its family carrying extra uninvited guests – for example, in the United States, animals sold in pet stores often come from regions of the Southeast where parasite incidence is very high, whilst in Europe many dogs from eastern countries are being relocated to western areas where parasitic diseases, new to the region, are now being identified. Furthermore, many "puppy mills" or "puppy farms" may not consistently use effective parasite control measures.

The movement of animals is not limited to finding homes in new locations; pets now travel more often with their owners than in the past. According to one study, 68% of dog owners travel with their pets (1). Holiday vacations, dog shows, sporting events and routine travel are often cited as reasons for the family pet to accompany their owners. While travelling, pets may have unexpected exposure to parasites which are novel to them. Dog parks, boarding kennels, exercise areas in rest stops, and dog shows may provide high levels of exposure to external parasites, the eggs of internal parasites, and vector-borne diseases. Emphasis on fecal removal and avoidance of areas of high concentrations of animals and vegetation is one means of minimizing this risk for exposure. Where available, review of parasite incidence maps of unfamiliar areas ***(Figure 1)*** to which the pet will be travelling may help veterinarians advise on the best means of parasite prevention

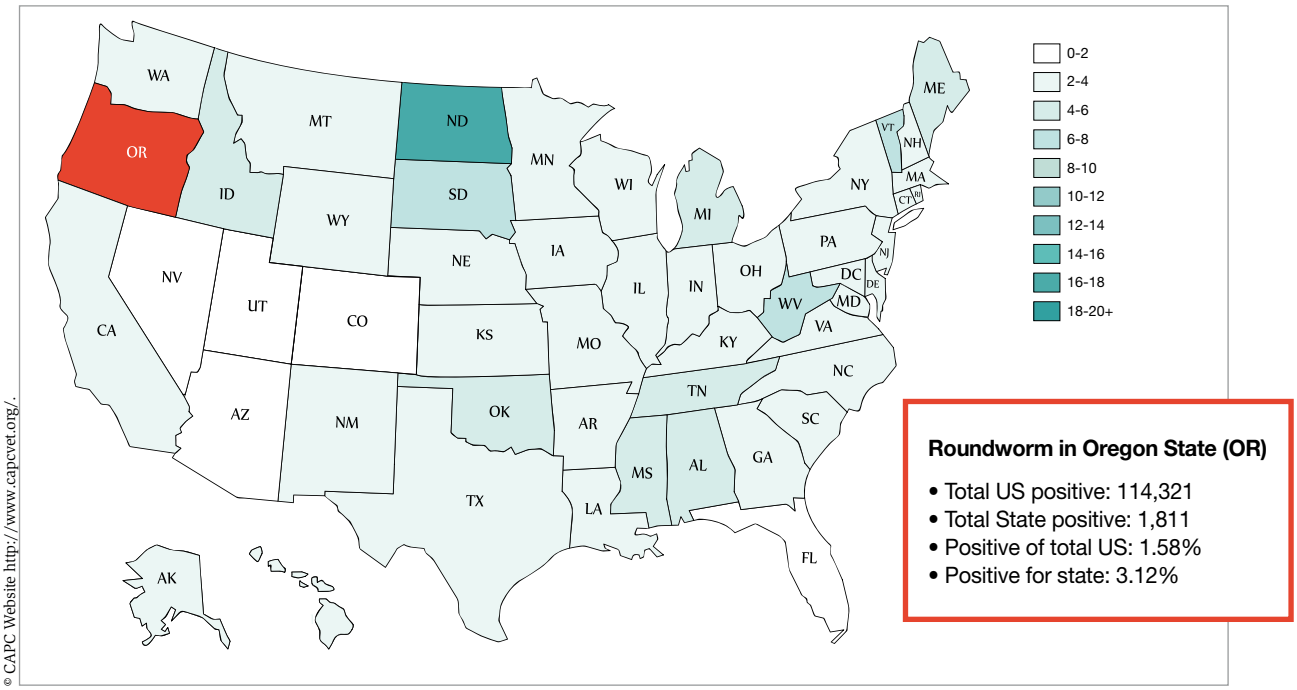
necessary during a trip. Since there are no universally consistent and comprehensive regulations relating to parasite control during internal and international transportation of pets it becomes very important for the practitioner to both inform clients as to effective means of protecting their pets whilst traveling and to test for parasites upon their return home.

The spread of vectors to new regions and the discovery that some diseases are being transmitted by vectors that were not previously deemed to do so is another challenge that practitioners face. As an example, the spread of heartworm disease in dogs and cats by mosquitoes was previously considered to be geographically limited due to environmental temperatures needed for development of infective L3 larvae in the mosquito. Several new species of mosquitoes that can transmit *Dirofilaria immitis* have been discovered recently, some of which may hibernate and live for 6-8 months (2). In addition, changes in environmental temperature and the development of microclimates associated with new building construction enable mosquitoes to propagate in regions previously considered to be free of these vectors. Consequently, heartworm is becoming established in areas that have been historically free of the disease. There are many other examples of the spread or introduction of parasite-associated diseases into regions of the world where they were not previously found.

Zoonotic disease

The threat of parasitic diseases of animals that can be shared with man accentuates the need for consistent prevention of these diseases in our companion animals and not just their treatment. The young and the elderly are most easily identified as having increased susceptibility to zoonotic disease, but those who are immunosuppressed or have chronic illness are also more susceptible than average. To the practitioner in the exam room it is not always immediately evident which owner is at highest risk, since a client may be undergoing chemotherapy, taking immunosuppressive drugs, or have a compromised immune system without obvious signs. Figures suggest that the incidence of diabetes in the USA is 8.3%, an estimated 25.8 million people of all ages. Seven million of these cases are undiagnosed and thus the individual may not even know he or she is more susceptible to a zoonosis. In addition the people seen in veterinary practices may have

Figure 1. Parasite incidence maps, such as this one on the CAPC website, can be useful tools when advising pet owners about parasite risks.



children or grandchildren, or may be providing care for an elderly person at their home. These considerations show the need for the veterinary practice to provide education on the prevention and control of potentially zoonotic parasites to every client that they see in their practice.

Canine and feline roundworms (*Toxocara spp.*) are a significant cause of ocular and visceral larval migrans in humans ***(Figure 2)***. Ocular larval migrans due to *Toxocara* is one of the major causes of loss of vision in an eye for children. One study showed the incidence of *Toxocara* in rescued shelter dogs in the US to be 14% (3). Coincidentally, a separate study found that the incidence of *Toxocara* in the human population was also 14% (4). The prevention and control of roundworms in companion animals is relatively well understood and easily accomplished with consistent periodic administration of any of several different broad-spectrum anthelmintics. The failure to control roundworms in our pets may increase the exposure of susceptible family members to disease.

Another zoonotic disease of importance is toxoplasmosis. *Toxoplasma gondii* is a parasite of cats that can be transmitted to people with sometimes damaging results. *T. gondii* can cause severe or even life-threatening lesions in the unborn baby when pregnant women become infected. Although most significant in pregnancy, the discussion of toxoplasmosis and zoonosis should not be limited to pregnant women. *T. gondii* has an infection rate of 10.8% in the US with an estimated 35.6 million people being involved (5). Higher rates of shedding of oocysts are found in other parts of the world such as 23% in Brazil and 41% in Egypt (6). Infective sporulated oocysts may survive in the environment for months or even years.

Heartworm, *D. immitis*, has long been recognized as a very important parasite of dogs with the disease being reported in approximately 250,000 dogs annually in all 50 US states (2). This parasite also has limited potential to be zoonotic, with hundreds of cases of human pulmonary dirofilariasis having been diagnosed. In fact *D. immitis* is known to infect more than 30 species of animals, including felines, where heartworm is gaining recognition as an important disease. Clinical signs (known as heartworm associated respiratory disease, or HARD) are attributed to larval stages of the parasite in this species. Since completion of the lifecycle to adulthood for the worm is not as common as in the dog, diagnosis of the disease in the cat is often overlooked; the use of both the antigen test (which show the presence of at least one gravid female) and the antibody test (which shows that the cat has had exposure to infective larvae) may be necessary when evaluating the feline patient for disease.

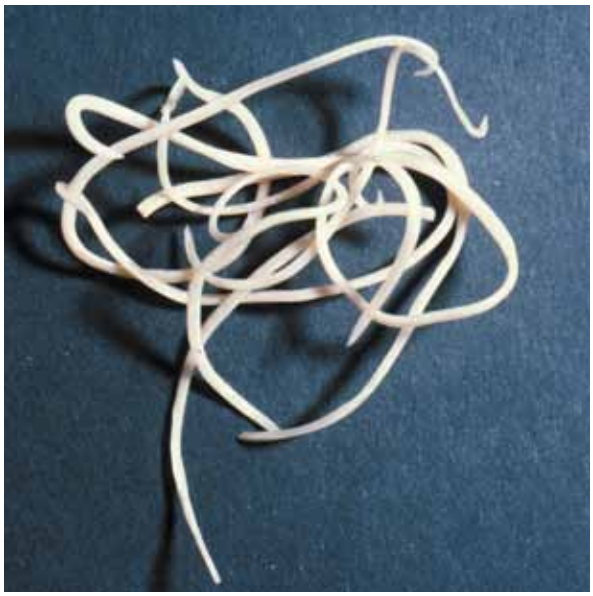


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Figure 2. Canine and feline roundworms (*Toxocara spp.*) are a significant cause of ocular and visceral larval migrans in humans.

This is by no means a comprehensive list of zoonotic parasitic diseases. When considering the relatively high incidence of parasites and their potential to cause zoonotic diseases clinicians may wish to increase their efforts to educate both clients and staff on the importance of parasite prevention. When compared to the low incidence of diseases that we routinely vaccinate animals for, and the fact that only a few of those diseases (*e.g.* rabies) are zoonotic, it becomes evident that veterinary practices may benefit from a paradigm shift to increase their emphasis on parasite prevention.

Compliance and protocols

The job of the veterinarian is not limited to diagnosis of disease and sharing of information with the client. Until the pet owner is motivated enough to take action, the condition of the pet will not

change. Therefore if best medicine is to be practiced, and client compliance is to be highest, it is important that the veterinarian and the practice become persuasive in how their message is presented. Compliance with treatment is highest when pet owners receive a "sticky" message that moves them to change behavior and take action (7). Each owner will be motivated to take action based upon their individual perspectives and circumstances; for some owners, protecting the health of the animal may be incentive enough, for others prevention of zoonotic transmission of disease to their children, granchildren, or themselves may be the important factor to institute parasite prevention. Providing an owner with many different bits of information to consider will help the message be retained and for the owner to take action at home.

The presence of fleas and ticks on pets serves as a strong motivator for the pet owner to seek relief for their pets ***(Figure 3)***. Client awareness of heartworm disease in high incidence areas may also serve as a strong incentive for compliance with the regular administration of preventative medicines. If the veterinarian recommends products that prevent and treat other parasites at the same time as these pests there is an opportunity to provide additional protection to the pet and family.

Various veterinary organizations have developed guidelines that can be used as a springboard to aid prevention of other parasitic diseases; for example the CAPC recommends that pet owners "administer year-round treatment with broad-spectrum heartworm anthelmintics that have activity against parasites with zoonotic potential."

Even though heartworm can be a strong incentive for some clients, a compliance study showed that only 48% of patients in heartworm endemic areas were current with their preventative medications (8). The difficulty associated with motivating clients to consistently follow-through with preventative care as well as other types of care should be viewed by the practitioner as one of the most significant challenges we face. Developing hospital-wide protocols for frequently encountered issues helps to ensure that staff members provide a consistent message to clients. Receiving a single, concise message with a strong, clear call for action on the pet owner's part helps increase the likelihood that the

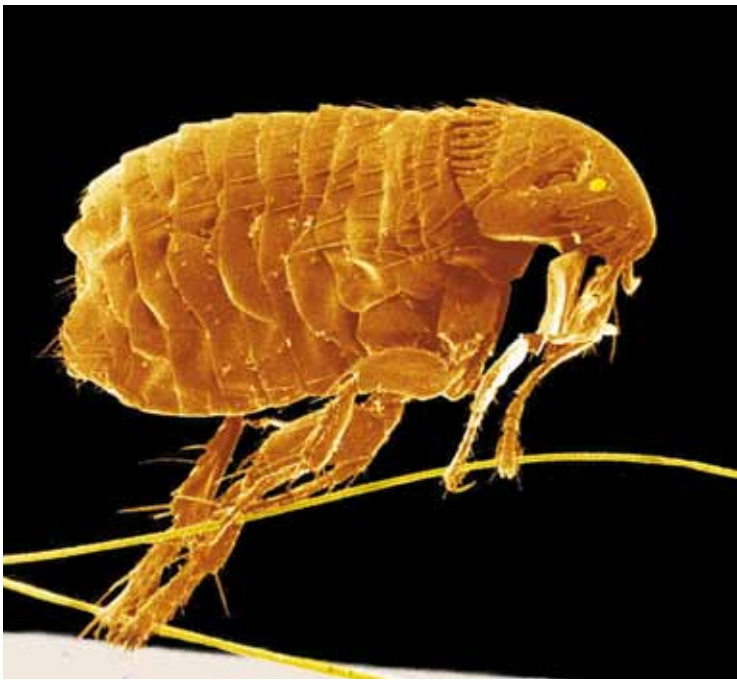

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Figure 3. The presence of cat fleas on pets serves as a strong motivator for the pet owner to seek relief for their animal.

pet owner will follow-through with recommended treatment. Most hospitals have clear protocols that are well developed for vaccinations, even though the incidence of the diseases that the vaccines serve to protect against are usually very low. Efficacy of modern vaccines and stringent protocols likely contribute to the low incidence of these diseases. Of the standard vaccines that are given in North America only a few have significant zoonotic potential (*e.g.* rabies, leptospirosis, and Lyme's Disease) ***(Figure 4)***. Protocols for parasite prevention are not as consistently utilized in some practices as vaccination protocols, yet when considering the relatively higher incidence of parasites in the general population of dogs and cats, and the potential for zoonosis, one must consider if our priorities are misplaced. Incidence levels of *T. canis* (14.54%), *Ancylostoma caninum* (19.19%) and *Trichuris vulpis* (14.30%) have been reported in stray shelter dogs (3). These numbers demonstrate that for the average veterinary practice there is a high potential to see parasitic disease on a daily basis. A recent study demonstrates that these internal parasite numbers can and are being reduced by up to ~ 90% in regions like the southeast US where veterinarians frequently advocate broad-spectrum heartworm preventatives (9). In

Figure 4. Tick species such as *Dermacentor reticulatus* can spread Lyme's disease.

other regions, where the perception by some veterinarians and owners is that the incidence - and therefore the risk - of heartworm disease is low, there is less reduction in internal parasite numbers; dogs cared for by veterinary practices in the western USA showed only a 22% reduction in internal parasite numbers when compared to shelter dogs in the same region.

The choice of products that are recommended by the practice should be considered when developing a protocol. A clear, concise recommendation without ambiguity will help prevent indecision by the owner and strengthen the likelihood of their follow-through with parasite prevention. Eggs of some parasites such as *Toxocara* may last in the environment for years and are often resistant to destruction. Environmental considerations therefore need to be included when developing a parasite prevention protocol.

Inconsistent messaging has the potential to confuse clients and greatly diminish their compliance. Establishing a parasite protocol that includes the education of all hospital members creates a culture of consistent messaging on parasite prevention ***(Table 1)***. Clients then receive the same instructions and philosophy on parasite prevention from veterinarians, the front desk staff, vet nurses and the kennel assistants, thereby enhancing compliance. When the staff can speak with one voice, communication with clients becomes more effective, so that owners can better understand and buy into the message of how to keep their pets parasite-free.

Parasite testing

Diagnostic methods for parasite detection need to be considered when developing a parasite protocol in a veterinary practice. Frequency and types of tests to be run should be evaluated for necessity by geographic location and demographic profile. Many commercial laboratories offer individual tests as well as bundled parasite screening profiles that may be utilized for diagnostics. This avenue for testing has an added benefit in that this information can then be compiled to provide statistics for study as well as developed into instruments such as interactive maps.

If testing is performed within the individual hospital there is the potential for more rapid reporting of results to the pet owner; this may help with more effective treatment of disease, as well as better compliance with adoption of preventative medications and techniques. The selection of which in-practice testing procedures should be performed is of importance. If in-hospital testing is selected for parasite detection, thorough training for laboratory personnel should be completed for consistency of

Table 1. The clinician can share information with owners regarding environmental modifications that may help to limit parasite incidence, for example:

- Limiting vegetation to minimize tick habitat close to the house.
- Frequent collection of feces where dogs roam will help to minimize contamination of grounds.
- Educating owners on changing cat litter boxes daily to eliminate *Toxoplasma* oocysts before they become infective (1-5 days).
- Covering children's sandboxes when not in use.
- Mosquito control, including use of screens to minimize pet contact with mosquitoes, should be considered in certain areas.

reporting; this includes both sample preparation and microscopic evaluation.

Prevention and treatment

Due to the large number of potential parasites and differences in regional incidence and circumstances of the individual pet, it is impossible to make a single recommendation for appropriate therapeutics. Since these decisions may be challenging for the practitioner who has had formal education on the topic, it should be clearly evident that this choice should not be left strictly to the pet owner. There are a wide variety of products available for control of parasitic diseases, and not all compounds are available in all countries. Variations in spectrum, route of administration and efficacy should be considered when making a recommendation.

Conclusion

Advances in the understanding of life cycles and parasite biology, as well as development of highly effective broad-spectrum parasite preventative medications, now allow veterinary practitioners to be proactive rather than reactive when it comes to parasite control. While most veterinarians have an understanding of the parasites that they encounter within their own practices, they should not be lulled into complacency when it comes to the understanding of parasitic diseases. The world of animal parasites and methods for their control are constantly changing, and many parasites carry the potential for zoonotic infection.

Since human physicians usually receive limited education on parasitic diseases they may provide inaccurate information that can have a negative impact on the relationship of the family and their pets. To assure a more knowledgeable and balanced understanding of the relationship of zoonotic diseases and their impact on all members of the family, both human and animal, veterinarians must routinely have discussions with their clients on this topic; this will provide an accurate perspective on zoonotic diseases and their prevention, so that the human-animal bond can best be preserved.

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Geriatric clinics in practice

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Dr. Davies graduated from the University of London in 1976 and ran his own practice for 11 years before working in both academia and industry. He has post-graduate qualifications in veterinary radiology, small animal orthopedics and clinical nutrition, and first developed an interest in geriatric medicine in the 1980's. Author of one of the first textbooks on veterinary geriatric medicine, he has been involved with various geriatric projects and currently runs a geriatric screening program at the University of Nottingham where he is Associate Professor in Small Animal Clinical Practice.

Introduction

As animals age a variety of changes occur which makes the management of elderly animals both interesting and, at times, challenging. Two main types of change occur concurrently:

Aging

Aging changes that typically occur in tissues are predictable and progressive and they ultimately result in decreased organ reserve and impaired functionality but, by themselves, aging changes do not cause disease. Some of the typical aging changes are listed in ***Table 1*** and the combined effects of these result in altered neuroendocrine function, reduced ability of the animal to respond to stress (such as the metabolism and elimination of drugs), and reduced ability to mount a robust immune response if exposed to pathogenic agents; wound healing may also be impaired.

Age-related diseases

In addition to aging changes, elderly animals often have concurrent age-related diseases, many of which can be subclinical for many weeks, months or even years before signs become obvious to the owner or clinician ***(Table 2)***. A good example is mitral regurgitation secondary to endocardiosis in dogs. With advancing age the severity of the lesions on the atrio-ventricular valve(s) progresses ***(Figure 1)*** and one study found that 58% of dogs had severe disease by the age of 9 years (1). As the lesions progress regurgitation gets worse, reducing ejection volume and, in an attempt to maintain cardiac output, homeostatic mechanisms kick-in, including stimulation of the renin-angiotensin-aldosterone system and the sympathetic nervous system. Therefore although a murmur can be heard on auscultation, the underlying disease is masked, and it can take years before the condition decompensates; medical intervention is usually reserved until the dog shows clinical signs of heart failure. However, reduced cardiac output results in decreased blood supply to all organs resulting in local hypoxia, and impaired venous return results in congestion with consequential decreased removal of waste products from tissues. Essentially dogs in heart failure have impaired multiple organ function ***(Figure 2)***.

The possibility of age-related diseases needs to be considered at all times as their presence alters the way that the animal should be managed; for example changes in exercise pattern - from long to short walks - might be recommended for dogs with osteoarthritis, and dietary changes may be advisable; the introduction of a weight loss program is needed for obese

KEY POINTS

- Pet owners often do not recognize the importance of signs that are commonly present in animals with age-related diseases, and may not report them to the clinician.
- The most important part of a geriatric screen is the acquisition of a detailed history and the findings of a good physical examination.
- Urinalysis is the most important diagnostic test to perform in geriatric animals.
- Screening helps to identify unrecognized problems resulting in early investigation, diagnosis and treatment, leading to optimized patient management and improved quality of life.

Table 1. Common age-related tissue changes (after Merck 2011).

Affected organ/system	Physiological change	Clinical manifestations
Body composition	Reduced lean body mass Reduced muscle mass Reduced creatinine production Reduced skeletal mass Reduced total body water Increased % adipose tissue	Changes in drug levels Reduced strength Tendency towards dehydration
Cells	Increased DNA damage Decreased DNA repair ability Reduced antioxidative capacity Accelerated cell senescence Increased fibrosis Lipofuscin accumulation	Increased cancer risk
Ears	Loss of high-frequency hearing	Reduced responsiveness to sounds
Endocrine system	Decreased and/or increased hormone synthesis/ secretion	Multiple consequences depending upon the relative hormone activities *e.g.* if animal develops hypo- or hyperthyroidism
Gastrointestinal tract	Reduced splanchnic blood flow Increased transit time	Tendency towards constipation and diarrhea
Heart	Reduced intrinsic heart rate and maximal heart rate Blunted baroreflexes Increased atrioventricular (AV) conduction time Increased AV ectopy Increased valvular regurgitation Increased myocardial cross-linking	Tendency towards syncope Reduced ejection fraction
Immune system	Reduced B-cell and T-cell function	Tendency towards some infections and possibly cancer Reduced antibody response to immunization or infection Increased auto-antibody formation
Joints	Degeneration of cartilage Fibrosis Reduced elasticity	Tightening of joints Tendency towards osteoarthritis
Kidneys	Reduced renal blood flow Reduced renal mass Reduced GFR Reduced renal tubular secretion and reabsorption Reduced ability to excrete a free-water load	Changes in drug levels with increased risk of adverse drug effects Tendency towards dehydration
Liver	Reduced hepatic mass Reduced hepatic blood flow Reduced activity of P-450 enzyme system	Changes in drug level Risk of drug toxicity
Nose	Reduced ability to detect smell	Reduced taste sensation Reduced appetite
Peripheral nervous system	Reduced baroreceptor responses Reduced β-adrenergic responsiveness and number of receptors Reduced signal transduction Reduced muscarinic parasympathetic responses Preserved α-adrenergic responses	Tendency towards syncope Reduced response to beta-blockers Exaggerated response to anticholinergic drugs
Pulmonary system	Reduced vital capacity Reduced lung elasticity Increased residual volume Decreased forced expiratory volume Ventilation/perfusion mismatch	Increased likelihood of shortness of breath during vigorous exercise Increased risk of death due to pneumonia Increased risk of serious complications if there is a pulmonary disorder
Vasculature	Reduced endothelin-dependent vasodilation Increased peripheral resistance	Tendency towards hypertension

animals; and drug selection may need to be modified or the dose rate or interval of dosing changed if an animal has hepatic or renal disease.

Aims of Screening

Pet owners often do not recognize the importance of signs that are commonly present in animals with age-related diseases, such as increased thirst, weight loss, exercise intolerance and excess weight (2), and they do not report them to the attending veterinarian. It is therefore important to educate clients on what they should look for, and to screen their animals for unrecognized signs. The aims of screening elderly animals are multiple:

1. To detect signs of age-related disease, thus allowing both early diagnosis and early intervention. Early intervention can have several key end-points:
- Remove pain
- Increase the likelihood of successful treatment
- Improve quality of life
- Delay progression of the condition
- Prolong lifespan

2. To identify risk factors in the animal's lifestyle – such as inappropriate feeding practices.

3. To obtain baseline physiological values or blood biochemistry/hematology values for the animal which can be used for comparison with tests performed at a later date.

4. As a benefit to the practice by:
- Strengthening client-practice bonding
- Meeting client expectations for quality life-time care for their pet
- Generating additional revenue

Geriatric screening programs

It may be appropriate to question if geriatric screening should be optional or mandatory. Routine screening can be optional but, in my opinion, screening of elderly patients should be mandatory in some circumstances:

1. Prior to general anesthesia.

2. Prior to the administration of drugs with a narrow therapeutic index, especially some frequently used drugs including NSAIDs, ACE inhibitors, acetylpromazine, medetomidine and dexmedetomidine.

Over the years I have been involved with several different formats for running a geriatric clinic in first opinion practices:

- **Format 1**. The clinic is promoted as a premium service – clients are charged a relatively high fee to include the cost of examination, a full panel of blood serology and hematology, urine tests, fecal examination, blood pressure monitoring, chest radiographs, electrocardiogram, intraocular pressure measurements, etc. Some practices run such programs

Table 2. Some common age-related diseases in dogs and cats.

Dogs	Cats
• Obesity • Dental disease • Endocrine diseases - Hyperadrenocorticism - Diabetes mellitus - Hypothyroidism • Renal disease • Prostatic disease • Acquired chronic valvular disease • Liver disease • Acute pancreatitis • Degenerative joint disease • Neoplasia	• Obesity • Dental disease • Endocrine disease - Diabetes mellitus - Hyperthyroidism - Acromegaly • Renal disease - chronic, acute • Feline triad syndrome - Inflammatory bowel disease - Pancreatitis - Cholangitis/cholangiohepatitis • Neoplasia • Degenerative joint disease • Constipation • Vestibular syndrome

successfully but, whilst this type of screening provides the most information, in my experience the uptake rate by clients is poor.

• **Format 2.** The clinic is promoted as a special service with clinician/nurse time charged at normal consultation rates and all tests done are charged at normal rates. This format is successful but in my experience the uptake is relatively low.

• **Format 3.** A free consultation (history and physical examination) and urinalysis is offered with any additional tests or investigations charged at normal rates. In my experience this is the most successful protocol with the highest uptake. If clients are invited to attend by a cold mailshot the uptake can be 18% (3); however if invited personally by practice staff most clients will agree to attend.

History

The most important part of a geriatric screen is the acquisition of a detailed history and the findings of a good physical examination. The longer I allow clients to talk the more useful information I obtain, and sometimes a key issue will take 20-30 minutes to be mentioned. I prefer not to view previous clinical records until after I have examined the animal and there are 3 stages to history taking:

1. Firstly, an open question asking what changes the owner has noticed as their pet has aged.
2. Secondly, a basic fact-finding history including details about lifestyle, exercise, feeding, drinking and toileting. This elicits details about vaccination status and preventative medicines (*e.g.* endo- and ecto-parasiticides) that the owner uses, concurrent medications that the animal is taking, and previous illnesses that the animal may have had.

3. Finally I take a detailed prompted history covering all body systems.

Physical examination

Many practices may delegate their geriatric screening to veterinary nurses/technicians, and they can play an important part in running a program; however, as the objective of screening an animal is to identify signs of common age-related diseases it is necessary that a qualified veterinarian performs a full physical examination that includes the following:

1. Ophthalmoscopy assessment
2. Neurological examination
3. Cardiorespiratory examination
4. Palpation of the abdomen
5. Otoscopy examination
6. Rectal examination (for male dogs)
7. Musculoskeletal evaluation

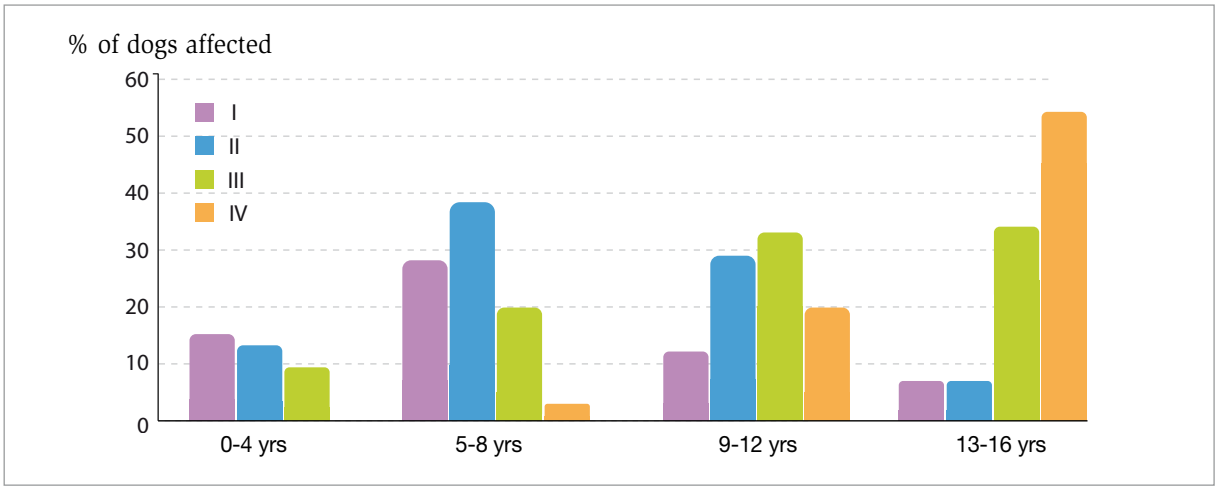
Of course nurses can be involved in other parts of the screening process, including some of the history taking, weighing the animal, urinalysis, blood testing, etc, but most nurses will not have the clinical knowledge to explore in-depth signs that may be described during the history taking and this is best done by a veterinarian.

Diagnostic tests

Urinalysis

In my opinion urinalysis is the most important test

Figure 1. Progression of severity of atrioventricular valve lesions with advancing age (graded in increasing severity from I to IV) in dogs (after 1).



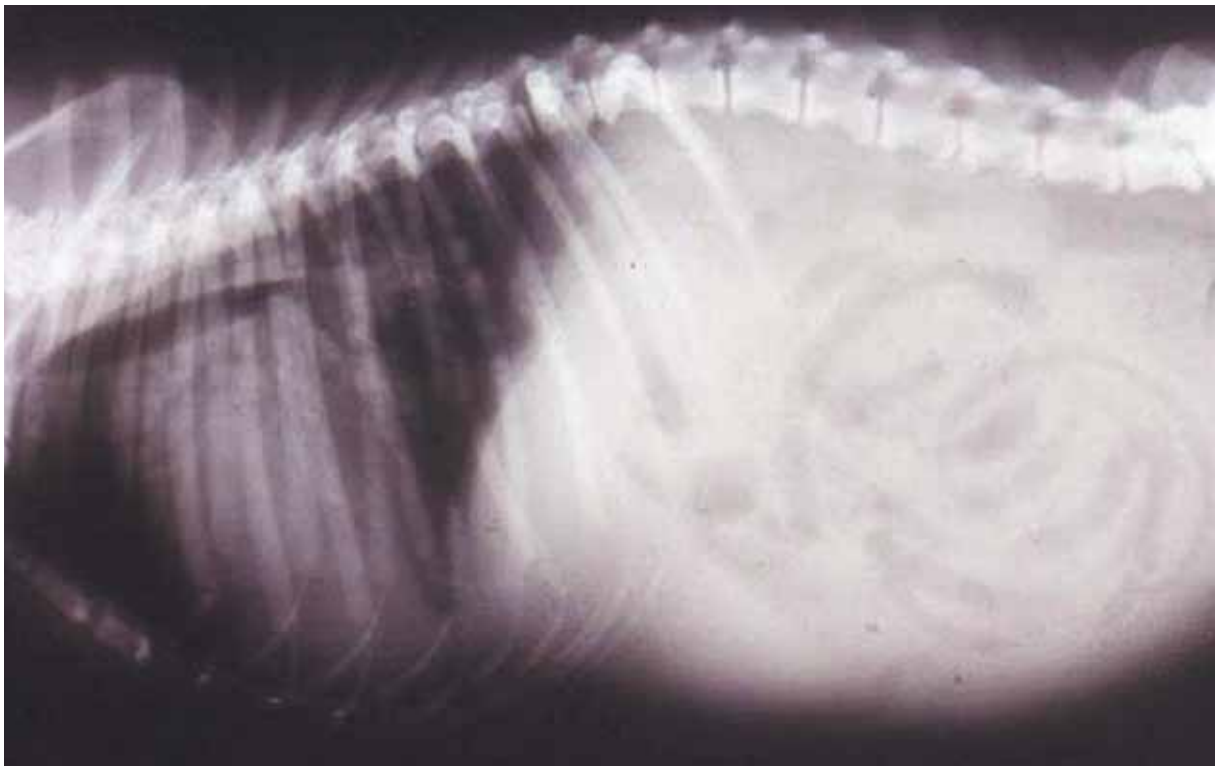


Figure 2. Lateral radiograph of a 8-year-old crossbreed terrier with congestive heart failure demonstrating not only cardiomegaly but also evidence of secondary problems including poor body condition, hepatomegaly and ascites with, presumably, congestion and poor perfusion of all abdominal organs.

to perform in geriatric animals, and a dip-stick test, specific gravity determination by refractometer, and microscopic examination of sediment are fairly cheap and quick to perform. Any abnormalities warrant further investigation.

Note many owners may fail to bring in a urine sample – up to 27% in one study (Davies - unpublished data). In this study, which involved 107 animals, 18% showed no abnormal findings on dipstick analysis whilst a low positive protein content was found in 25% of samples; this was not regarded as being clinically significant because the samples were collected by free catch. However a further 11% did have significantly high levels of protein, and other abnormalities included the presence of glucose (3%), ketones (1%), and bilirubin (4%). 19% of samples produced positive leucocyte results but only 3% were corroborated by microscopic examination of urine sediment; similarly of 6% positive for blood only two-thirds of these had red cells present on microscopy. Urinalysis whilst conducting geriatric screens has stimulated further diagnostic tests which subsequent unmasking of various occult diseases including urinary tract infections/prostatitis, liver disease, chronic kidney disease, hydronephrosis and neoplasia.

For example, I have seen several patients with persistent hematuria which were subsequently scanned and found to have transition cell carcinomas (TCC) of the urinary bladder in the absence of signs typical of lower urinary tract obstruction ***(Figure 3)***. This raises a question; does TCC usually locate at the bladder neck, or do we only detect them when they do occur at this site because that is when clinical signs become evident?

Blood testing

Ideally a full hematology and biochemistry panel should be performed, but the cost of these can be a barrier for many owners. In my experience a single blood sample is not always that helpful and, for several reasons, may be confusing:

1. A single blood screen is of limited value as it only gives a snapshot of blood constituents at the time the sample is taken and, unless serially repeated,

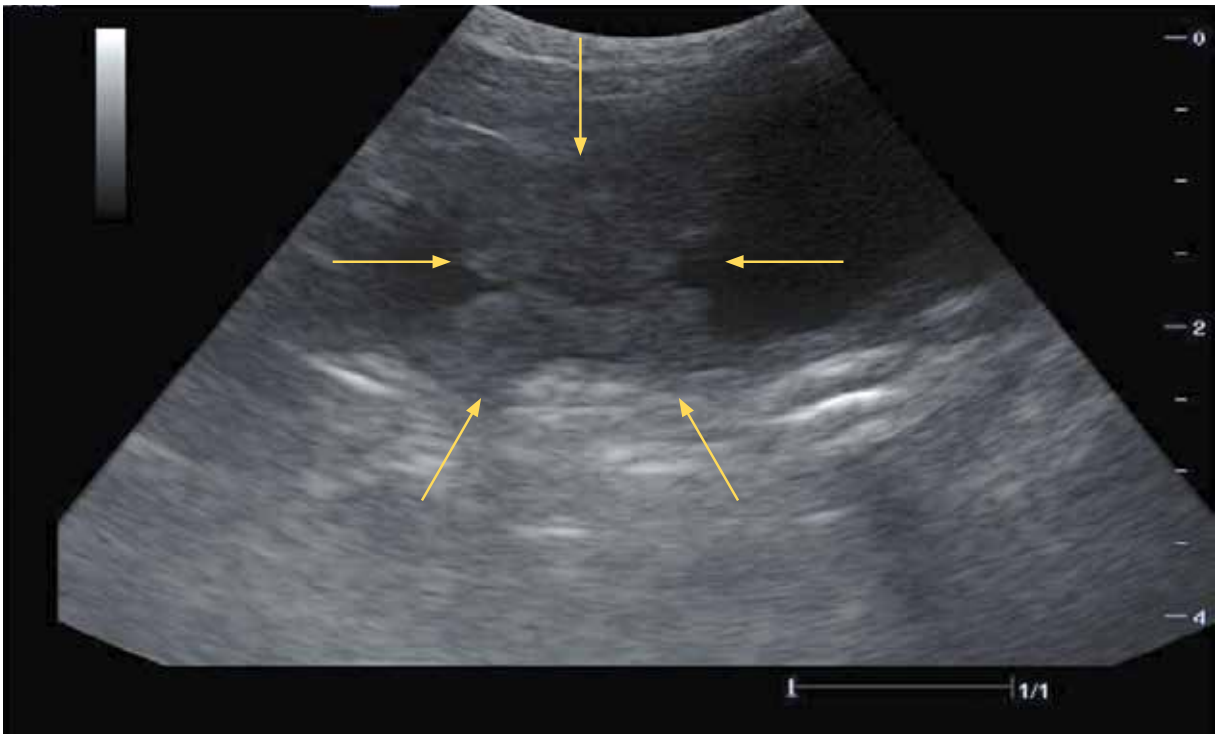


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Figure 3. Ultrasound image of a transition cell carcinoma in the urinary bladder of a 15-year-old domestic shorthaired cat; the animal showed no signs of urinary tract disease other than persistent hematuria. The tumor was excised but recurred 8 months later; however the cat remained free from clinical signs.

cannot be relied upon to represent the usual values to be found in the animal.

2. The chances of finding a relevant abnormal blood result in the absence of clinical signs identified from the history and physical examination are low (4).

3. For any given test one result outside the normal reference range can be expected to occur in 5% of normal animals – so 1 in every 20 dogs or cats screened would have an abnormal result that is not relevant, and the chances of getting at least one false negative or positive result in a panel of 20 blood tests is 64% (5). So abnormal findings require repeat testing to confirm validity.

4. The cost of blood tests (including repeat tests to rule out false positive or negatives) would have to be borne by the client, and this may be a disincentive to enter pets into the screening program for people with limited disposable income.

5. Diagnostic venipuncture is an invasive procedure with the potential for complications. In humans the minor complication rate (bruising and hematoma) has been reported to be 12.3% but serious complications were observed in 3.4% of patients (6). Accurate figures are not available for venipuncture in first opinion veterinary practices but, whilst serious complications may be rare, minor complications such as bruising and hematomata are relatively common.

Generally I prefer to run bloods as part of the screen only if indicated from the history or physical examination. The question may be posed; "whilst you do not do routine blood tests as part of your initial screen, what tests should be included in a blood panel for an elderly patient if a blood test is to be performed?" My answer is that "the aim of a geriatric screen is to look for evidence of the common conditions that one might expect to find, so all the blood tests that are reliable, affordable and needed to help rule in or rule out the presence of common age-related diseases in that species/breed should be included". For example, if a clinician does not screen for T4 in dogs or cats then there is a failure to obtain information that might help towards confirming or excluding a thyroid problem – even though a single result might not be that helpful,

especially in dogs with hypothyroidism. A normal result might not rule something in or out, but an abnormal finding would at least prompt further investigations to evaluate its significance.

Radiographic screening

Screening thoracic radiographs have been recommended as part of a geriatric screening program, and in one study significant thoracic abnormalities including cardiac enlargement and lung disease were found in 17% of cats over 11 years of age and 4% of dogs over 7 years of age (8). Personally, I do not recommend chest radiographs unless indicated from the history and/or physical examination. Most animals require sedation to obtain good quality radiographs and the use of the common sedatives are not without potential complications in elderly patients. Acetylpromazine is a potent hypotensive agent and should be used with care, whilst medetomidine and dexmedetomidine are both contraindicated in animals with cardiac or respiratory disease - and their datasheets state that blood screening to rule out the presence of renal or hepatic disease is a prerequisite before they are administered to elderly animals.

Other diagnostic tests

Blood pressure monitoring, intraocular pressures, retinal imaging and other investigations can all add valuable information about the animal, but for routine screening they can be time-consuming and add considerably to the cost if free screening is not being offered. I am currently evaluating the value of some of these modalities to see if their inclusion in routine screening can be justified.

Expected outcomes

Pre-anesthetic screening of geriatric dogs has been shown to be very useful clinically; in one study 13% of dogs did not undergo planned anesthesia as a result of the findings, whilst new diagnoses were made in 30% of the dogs (8). In the UK many practices run geriatric screening centered on blood tests but pre-anesthetic blood hematology and serology tests by themselves may not be very valuable (4).

Conducting a geriatric screening program is extremely rewarding as new medical problems can be expected to be found in up to 80% of cases examined (3,8), and even in the animals where no new condition is discovered there are always issues to discuss with the owner, such as correcting poor lifestyle factors, including inappropriate diet, bodyweight control and exercise regimens. For dogs with subclinical or mild disease, advice can be given about avoidance of risk factors that might hasten progression of the disease, complementary management protocols such as nutritional supplementation can be implemented, and a rational series of re-examinations can be planned at a frequency that is appropriate for that animal.

One study involving 45 dogs conducted in my own clinic (8) revealed an average of more than seven problems per dog, some of which were serious and even life-threatening, including severe respiratory distress, metastatic pulmonary neoplasia, and abdominal tumors; nearly a quarter of the dogs were in pain. In addition to the clinical findings, owners really appreciate the time that is spent with them during a geriatric consultation. They often book their other elderly pets in for examination, and they recommend the program to their family and friends.

In financial terms the opportunity to increase practice income can be considerable; personal experience has shown that a «free» geriatric consultation can generate an average income per case that approximates to four times that of a standard consultation fee.

Re-examination intervals

For most conditions the optimal frequency of re-examination has not been determined. Many animals requiring repeat prescription medicines for chronic disease are typically re-examined every 6 months but this may not be the optimal frequency for the animal, and I currently prefer to see animals over 10 years of age every 4 months. For some conditions there are good guidelines, *e.g.* the International Renal Interest Society (IRIS) recommendations for chronic kidney disease advises different frequencies of re-examination depending on the status of the animal, and sometimes 2 monthly re-evaluations are recommended.

Unexpected outcomes

Whilst the positive benefits of running a geriatric screening program are clear, the unexpected can sometimes occur - I recently examined a dog, presented for routine screening, which was cyanotic and in

severe respiratory distress. Onset had been gradual and the owner did not even realise that her dog was having breathing problems.

Other cases can have unexpectedly negative outcomes; this is especially true when an owner has an active, apparently healthy animal which is found to have a serious problem. A typical example was a lively border collie which had a small irregular tumor in one of her caudal mammary glands. The options for conservative management or further diagnostics with a view to possible surgery were discussed with the owner. As the dog seemed well the owner elected for early surgical removal rather than a fine needle aspirate or simply monitor tumor growth. The history and physical examination, including auscultation of the chest, found no respiratory abnormalities but unfortunately, and unexpectedly, screening thoracic radiographs showed the presence of advanced metastatic lung tumors. The client elected for euthanasia before her dog was clinically affected by the condition.

However, simply offering a geriatric check may act as a stimulus for owners to seek advice. An elderly English pointer presented to my clinic with fecal incontinence; the owner told me that the invitation to attend the geriatric screen had given her a valid reason to bring the dog to the practice – even though she knew the likely outcome, she would never have taken the decision herself to have him euthanized.

Conclusion

Owners often do not recognize the importance of signs that are typically seen in serious age-related diseases, and as a result they will not report them to their veterinarian. Screening helps to identify unrecognized problems resulting in early investigation, diagnosis and treatment. As a result patient management can be optimized; not only to relieve pain and improve quality of life, but also may prolong life itself.

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Better compliance in preventative medicine

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KEY POINTS

- Most veterinary practices are aware of how important compliance is, yet very few understand it, measure it or have a conscious strategy to improve it.
- The veterinary team often carries a large part of the responsibility for poor compliance. Good compliance starts by the whole team applying standard protocols consistently.
- Good communication can be underlined by the use of printed matter, but no brochure can ever replace personal communication.
- Effective follow-through is one of the keys to successful compliance, and can make the difference between a mediocre outcome and a truly satisfying result.
- Recording recommendations and follow-through can allow measurement of compliance and enable action to improve it.

Introduction

The development of compliance in preventative medicine is a strategic objective for veterinary clinics. Indeed, compliance has a direct impact on the health of the patients, the quality of care, and client satisfaction. Paradoxically, although the majority of veterinary clinics are perfectly aware of how important it is, only a minority of vets truly understand what compliance means, measure it (and thus make it possible to determine the extent of the problem), and implement a conscious strategy to improve it.

One of the first areas of misunderstanding comes from an erroneous interpretation of what compliance really means ***(Table 1)***, and compliance should be distinguished from adherence. Compliance measures the overall rate of application of a given preventative measure (for example the annual health check or the annual senior health check) in comparison with the number of animals for which the procedure is indicated. Adherence measures the rate of application of a prescribed treatment (for example wormer/flea treatment or a life-stage diet). Put another way, adherence is related to the client's behavior (and sometimes that of the animal!), whilst compliance involves the team at the clinic first and then that of the client. In veterinary medicine, as in human medicine, compliance rates are highly variable depending on which protocols are selected. In both veterinary and human medicine, healthcare professionals generally over-estimate compliance rates. One study in dogs (1) showed that compliance varied from 87% for basic vaccines to only 35% for dental prophylaxis or annual senior health checks.

The vet – owner – patient triangle

In veterinary medicine, compliance is complicated by the fact that the "healthcare professional – patient" duo is replaced by a "vet – owner – patient" trio ***(Figure 1)***. Sources of poor compliance are therefore more complicated to analyze.

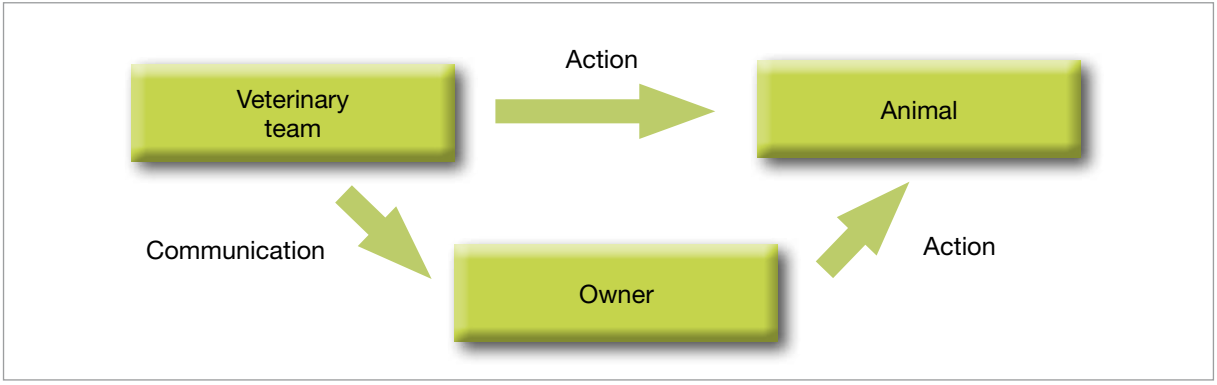

Figure 1. The "trio of compliance".

The patients themselves can be the cause: they do not allow their owner to apply a spot-on treatment, or they refuse to eat a certain food, or they make themselves scarce and are not around when the owner needs to administer a treatment or make an observation.

The owners are often an obstacle to compliance, as they did not listen to or understand the recommendations of the veterinary team, or because they do not really agree with the advice. Even when the recommendation is clearly heard, understood, and accepted, the owner may encounter difficulties when applying it, either practically (the recommendation is too difficult to implement) or economically (the recommendation proves to be too expensive).

The team at the clinic often carries a large part of the responsibility in poor compliance rates. Firstly, through an absence of recommendation (thus making it difficult for the owner and the patient to comply with it!), or through a lack of knowledge (which is rare), or through a lack of time or poor communication (which is very common). Poor communication can take many different forms, such as vague instructions that are unconvincing (often because the prescriber is not completely convinced), or an information overload (and hence difficult to understand and with no clear summary), or contradictory messages from different members of the same team. Note that one of the reasons for the absence of recommendation (or for inoperative recommendations) resides in the pre-conceptions of the prescriber – veterinarian, nurse, or receptionist – whereby assumptions are made as to the client's ability to understand advice or their propensity to accept and pay for a given procedure. ***Table 2*** summarizes the sources of non-compliance, taking dental prophylaxis as an example.

Table 1. Definitions

Compliance: *the extent to which pets receive a treatment, screening, or procedure in accordance with accepted veterinary healthcare practices. Compliance involves both veterinary staff performing and/or recommending treatments, screenings, and procedures, and pet owner follow-through.*

Adherence: *the extent to which patients take medications prescribed, involving the pet owner in filling and refilling the prescription; administering the correct dose, timing and use; and completing the prescribed course. Adherence is a term applied specifically to medications; it does not refer, for example, to recommendations for wellness checks, diagnostic screenings and so on.*

What are the sources of poor compliance?

Poor compliance can originate from several sources; one example is given in ***Figure 2***.

- The diagnosis may be the problem, in that the veterinary team does not identify that an animal has presented with an indication for a given procedure. This stage may seem to be of little consequence in preventive medicine, yet it is still important. For example, if the clinic is not organized to actively and systematically identify those animals that are entering the senior phase of their lives within the next year, there is little chance that an annual senior health check will be recommended to the owners.
- The recommendation or prescription is often defective; when looking at increasing compliance,

a major target is to improve the rate at which clinicians make clear recommendations that conform to the clinic's current protocols.
- The implementation of the recommendation by the owner represents the third source of non-compliance. Note that adherence is measured by comparing the rate of implementation to the rate of recommendation, whilst compliance is measured by comparing the rate of implementation to the needs of the animal according to the consensus of the profession.

Compliance has been analyzed by numerous authors as the sum or product of several elements; one authority (1) has suggested the so-called CRAFT formula, as follows:

Compliance = Recommendation + Acceptance + Follow-through

Whist another author (3) suggests that:

Compliance = Recommendation x Understanding x Acceptance x Follow-through

The author prefers the following formula:

Compliance = Diagnosis x Recommendation x Understanding x Acceptance x Actual implementation + Follow-through effect

So that compliance is the product of the five successive rates (each comprising a value between 0 and 1) from the diagnosis to the actual application, and not their sum, and the follow-through represents an opportunity for improvement for the medical team.

How can one improve compliance?

To enhance compliance, the author prefers a six-point action plan:
- Use agreed protocols to standardize diagnosis and recommendation.
- Set up a permanent process to develop the protocols which will promote compliance, simplify procedures, improve practicalities, etc.
- Work on "internal compliance", *i.e.* the actual and systematic application of the protocols by all members of the team, everyday.
- Improve the communication process between the healthcare team and the owners.
- Design monitoring schemes to enable early detection of the problems of compliance and the application of corrective measures.

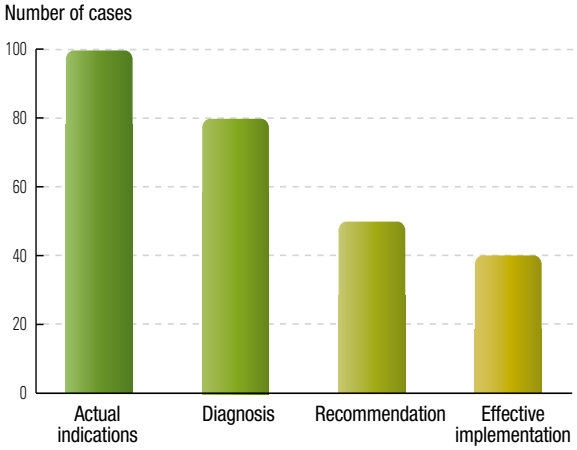

Figure 2. Sources of non-compliance. In the above example, the poor outcome (only 40% of cases received the appropriate treatment) is primarily the result of faulty diagnosis and lack of recommendation rather than because of inadequate adherence by the owner. For every 100 cases where there was an indication, only 80 were recognized (= diagnosed) by the vet and only in one case out of every two did the veterinary team make a recommendation. The owner implementation rate *(i.e.* the adherence) was good, applying the recommendation in 80% of these cases - but this meant that only 40% of cases were actually treated.

Table 2. Examples of sources of non-compliance for dental prophylaxis.

Veterinary staff	• The benefits of brushing were not explained. • Different members of the team gave conflicting information. • Certain members of the team have prejudices regarding the inability of the owner to brush their animal's teeth. • No practical demonstration was offered to the client.
Owner	• Was not convinced by the advantages of brushing. • Considers that it is too demanding. • Does not have time for regular brushing.
Animal	• Was not very co-operative!

- Develop a system to record compliance in order to measure it, which represents a key step to improving it.

The implementation of standard medical protocols ensures systematic diagnosis and optimal recommendations ***(Table 3)***. All protocols should be based on best practice and designed to provide an action plan for members of the team. They should be standardized and aim to homogenize behaviors for the better, and can - and should - evolve over time, to keep up to date with current opinion and benefit from the team's experience. If one vet recommends two wormers per year for a dog, whilst a colleague recommends four, what will the other members of the team think, and what will the clients do?

Other than scientific and medical considerations, it is recommended that current protocols in the clinic are reviewed and revised from a compliance point of view. For example, for a given protocol, is there any way of simplifying it to promote compliance without altering its medical performance? The simplest protocols are more easily understood and remembered, not only by the owners but also by the team. Particular attention should be given to achieving practicality for the owner in order to facilitate compliance: a spot-on is easier to administer than a tablet, a single injection at the clinic guarantees the implementation of a treatment whereas twice daily oral administration presents a serious risk that it is not implemented. At this stage, there is usually a compromise between price and practicality. It is important to present all options to the owner (the practical but most expensive solution *vs.* least expensive but harder to implement) and let them decide – unless of course the most practical is also the cheapest, when there is no conflict.

Table 3. Top 5 tips for better compliance

- Focus on key preventive medicine issues and implement a 100% veterinary recommendation for these cases.
- Improve «internal compliance» through appropriate training and monitoring, and implement an on-going team training process.
- Before every health check, verify the compliance of last year's recommendations in order to understand both the outcome of implemented recommendations and reasons for non-compliance.
- Design a limited numbers of simple communication tools to support the process and use client reminders to underline all preventive recommendations/prescriptions.
- Fully utilize the practice computer system by recording recommendations and then measuring the actual compliance rate.

Internal compliance and communication

Compliance starts with "internal compliance", *i.e.* the fact that the whole team applies the standard protocol all year round. To achieve this objective, awareness and training is essential; this also makes it possible to share the experiences of different members of the team and determine the best policies. Receptionists often have good experience of communicating with the owner and can offer very effective solutions. It is only possible to achieve effective recommendations or systematic follow-through if the whole team is fully convinced: if a veterinarian in your team considers that a protocol is unnecessary or too complicated, how will he be able to prescribe it correctly? If a nurse is not convinced by the advantages of brushing a dog's teeth, will she/he convince an owner?

Communication is clearly the key to the efficacy of the recommendation and therefore positively influences the understanding and acceptance of the client. Other than the standard rules of communication, which should be appropriate to the client – accessible language, frequent verification that the client understands and accepts the procedure, offering to answer any questions that they may have – it is important to structure the recommendation to ensure that it is effective. A six-step protocol is offered in ***Table 4***; particular stress should be made on two points:

- Obtaining the owner's consent is essential; it is strongly advised to conclude each recommendation with a concrete element that will allow the result to be monitored; for example, will the owner book an appointment for dental descaling or buy their first bag of senior food for their elderly cat?
- Complete a recommendation by use of a practical aspect, such as demonstrating the application of a spot-on, or by brushing the pet's teeth, or by explaining how to make the transition between

Table 4. Six-phase chart using the example of a post-neutering dietary recommendation for a cat.

The needs of the animal	"You have just neutered your cat, which is an excellent decision. However, as we explained when we took the decision together, his metabolism will quickly change, which is associated with a risk of weight gain, or even obesity." "In parallel, castration may increase the risk of urinary calculi. These two problems could have serious consequences for your cat's health, but thankfully they can be easily managed by providing an appropriate diet."
The appropriate response	"To prevent the two risks that we have discussed, it is important to give your animal a diet that has been specially designed for neutered cats. It will supply less energy whilst guaranteeing satiety. The mineral balance has been adapted to effectively reduce urinary calculi."
The actual offer	"This is why we recommend feeding diet X for your cat. Given the weight of your cat, we recommend giving 50 g per day." "This diet represents a daily cost of Y or an approximate monthly cost of Z."
Obtaining consent	"Do you have any questions?" "Would you like to use this life-stage diet?"
The practical aspects	"To ensure that all goes well, we advise a transition period between the current food and the new neutered cat food. Over two days, you can mix 25% of the new food with 75% of the old, then two days with 50% of each feed, then two days with 75% of the new and 25% of the old. You can then continue to give only the new neutered cat food." "We also advise dividing the daily ration into several small meals and making sure that your cat always has plenty of fresh water available in a dish that is at a distance from the feed dish. I will ask one of my nurses to call you in a week's time to find out how you are getting on with the transition."
Formalizing the recommendation	"I have summarized all of the information on this dietary prescription form, with the name of the food, the daily ration for the weight of your cat, and an explanation of how to conduct the transition." "One of my nurses will take you to the reception desk where she will give you your first bag and your promotional pack."

the usual diet and the new recommended diet. This phase is often neglected by the veterinary team, either because of time limitations, or because the action seems too obvious to require demonstration.

The efficacy of communication is largely improved by the use of a few simple tools, such as prescription forms (*e.g.* dietary prescription sheets), educational brochures or posters in the waiting rooms, and owner factsheets. A few very important points should be remembered regarding these tools:

- Over-abundance is as counterproductive as a shortage.
- Prioritize simple and targeted documents over those that are too long and general; for example a double-sided page explaining the advantages, practicalities and disadvantages of neutering a cat will be more effective than a 12-page booklet that covers every aspect of a cat's health.
- No brochure can ever replace personal communication between the healthcare professional and the owner; such tools should be used as a relay and not as a substitute.

Effective communication conveyed by a few simple tools can enable very ambitious results. Clearly, the owner must understand the recommendation. It is also important that they are convinced of its scientific grounding and of the benefit to both their animal and themselves. However, as well as this, it is also important that the client is convincing when they

return home and have to explain the vet's recommendations to their partner, parent, or friend, with good arguments to underline the decision. Too many clients leave the clinic convinced but change their minds because they were unable to explain the recommendation to a third party or respond to an objection. Communication tools are very useful to help clients to be convincing once back home, because they may be used as "recommendation reminders."

Follow-through and recording results

Follow-through is one of the keys to successful compliance, and may make the difference between a mediocre performance and a truly satisfying result. This involves appreciating that the work of the healthcare team is not finished when the recommendation has been undertaken in accordance with the protocol, even if the owner has accepted the concrete element that made it possible to verify their acceptance (*e.g.* booking an appointment or making a first purchase). The follow-through starts very soon after the recommendation and may take several different forms.

- Reminders are very useful for improving follow-through, notably when the action that the owner must take is relatively distant in time. For example, if one prescribes surgical neutering to the owner of a female puppy before puberty, *i.e.* two or three months after the recommendation, it is useful to offer to send a reminder two months later to ensure that the owner does not forget this important step. In this case, the reminder may take the form of a letter, but an e-mail, containing a link to the section on the clinic's website that describes the advantages and procedure involved in neutering, may be better.
- A telephone call can also help to ensure that compliance is on the right road. For example, when a new diet is prescribed to the owner of a recently neutered pet, or one that has recently entered the senior stage of its life, a member of the team can call to check that the transition period between the two diets has been smooth and without problem. This type of active approach is extremely well perceived by the owner and enables rapid adaptation of the recommendation should there be a problem, rather than waiting several months to find out.

Recording the various events can both measure compliance and allow action to improve it. Essentially this involves transforming the practice's computer software program into a real Customer Management System, where in addition to recording medical events, diagnoses, and treatments in the patient record, each prophylactic recommendation is recorded and notes are made as to whether the owner accepted it, if a follow-through procedure was undertaken, and if compliance was acceptable. Thus before starting any annual health check, the clinician has a summary not only of the animal's medical history, but also of all the events of the practice's relationship with the client. For example, the veterinarian will know that a dental descaling procedure was prescribed for Mrs Smith's Yorkshire terrier; this had indeed been performed, and that following the descaling the clinic had prescribed dental prophylactic measures, but that despite taking a first tube of toothpaste no second tube had ever been purchased. The vet could, either during the history taking or after examining the dog's mouth, broach this subject again and either renew the prescription, or adapt it to Mrs Smith's comments.

Conclusion

The development of compliance is a major issue for veterinary practices, not only from a medical point of view but also to strengthen the relationship with their clients and to allow economic development. It is a long-term project, which mobilizes the whole team in the design and implementation of a reasoned strategy. The main keys for success reside in adopting simple and concrete measures which should be systematically applied if they are to be effective.

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Vaccination regimes for dogs and cats

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Introduction

Since the 1950's, a large number of vaccines for dogs and cats have been developed and marketed worldwide, and more are in development. Nevertheless, it is estimated that in developed countries, only 30-50% of dogs are properly immunized, and possibly an even smaller proportion of cats. Proper immunization of a larger proportion of the pet population may help reduce the prevalence of infectious diseases.

In recent years, increased emphasis has been placed on vaccine safety for companion animals. A change from annual to 3-yearly immunization protocols for some vaccines has been recommended, with administration of other vaccines based on exposure risk. Guidelines for vaccine selection and administration have now been published by the American Association of Feline Practitioners (AAFP), the American Animal Hospital Association (AAHA), the American Veterinary Medical Association (AVMA), the European Advisory Board on Cat Diseases (ABCD), and the World Small Animal Veterinary Association (WSAVA) (1-4). Although there is some variation in the guidelines issued by the different societies, they can, together with a solid understanding of the principles of vaccination, help veterinarians make rational decisions about vaccination. This article will both review the major principles of vaccination and provide regimens for vaccination of pet dogs and cats for infectious diseases for which vaccines are widely available worldwide. Specific guidelines for shelter animals are now also provided by the WSAVA (4).

KEY POINTS

- Vaccines vary in their composition and ability to produce good immunity.
- Vaccines should be stored and administered according to product recommendations. Failure to do so can lead to ineffective immunization.
- Vaccines rarely protect all individuals that receive it from infection and disease. A large number of factors influence the production of an immune response.
- The clinician should be aware of the uses and limitations of antibody assays when assessing the immunization status of an animal.

Vaccine composition and vaccine types

Attenuated live vaccines replicate in the host, and usually stimulate an immune response that most closely mimics the protection that results from natural infection. Immunization with attenuated live vaccines, in the absence of maternally derived antibody (MDA), often results in rapid onset of immunity. For example, immunization with canine parvovirus (CPV) and distemper (CDV) vaccines can result in protective immune responses within 3 days of a single injection, which may be followed by immunity that lasts many years, if not life (5-7). Partial immun-

ity following immunization with attenuated live CDV and feline panleukopenia virus (FPV) vaccines can occur within hours (8-10). This makes attenuated live parenteral or intranasal (IN) vaccines the preferred choice in shelter situations. However, the potential for reversion to virulence or vaccine-induced disease exists with these vaccines; vaccine-induced disease is most likely to occur in highly immunosuppressed animals.

Inactivated vaccines are, generally speaking, less effective than attenuated vaccines, because they do not replicate in the host. They produce weaker immune responses of shorter duration, and more frequent booster immunizations may be required. Two initial doses of vaccine 3-4 weeks apart are essential to produce an effective immune response, and if more than 6 weeks elapses between these doses, it has been recommended that the series be repeated (2). Beyond the initial immunization series, it is not clear whether lapsed annual boosters require the series to be re-started. Restarting the series after lapsed annual boosters is not considered necessary for human immunization (11), but this has recently been suggested for dogs when more than 2 or 3 years elapses between boosters (2). Inactivated vaccines usually contain adjuvant as well as a large infectious dose to improve immunogenicity. They are generally safer than live attenuated vaccines for use during pregnancy, very young or debilitated animals. Although bacterin vaccines have historically been associated with a greater likelihood of allergic reactions than live attenuated vaccines, many inactivated bacterial vaccines now have reaction rates that more closely approach those of live attenuated vaccines. Inactivated viral vaccines were shown to have durations of immunity ≥ 7 years in cats (12), although it should be remembered that for respiratory pathogens, this does not imply complete protection from disease. The maximum duration of immunity that is induced by commercially available bacterins for dogs and cats remains largely unknown, partly because challenge studies that properly evaluate long-term duration of immunity are expensive to perform. Natural infection of immunized animals may further boost the immune response, which can influence duration of immunity in the field.

Subunit vaccines contain structural components of a microbe that stimulate a protective immune response, together with adjuvant. These may contain reduced amounts of foreign protein, which minimizes the potential for hypersensitivity reactions.

Recombinant DNA vaccines are created through manipulation of a pathogen's DNA in the laboratory, in order to negate its virulence.

Recombinant subunit vaccines are produced by cloning one or more genes for a protective antigen into an expression vector, such as *E. coli*. The protein produced by the bacteria is then purified and used in the vaccine. An example is the Lyme recombinant OspA vaccine for dogs available in North America.

Vectored vaccines are produced by insertion of genes that encode protective antigens into the genome of a virus that is non-pathogenic for the target host. The virus undergoes limited replication in the host and the antigens are expressed. An example of this method would be vaccines that use canarypox virus as a vector.

Vaccine storage, handling and administration

Vaccines should be stored and administered according to product recommendations. Inactivation can occur if they are inadvertently frozen or heated, exposed to excessive amounts of light, or used beyond their expiration date. Lyophilized products should be reconstituted with the proper diluent and vaccines should not be mixed; reconstituted products should be used immediately. Vaccines should only be used in the animal species for which they are labeled, or serious adverse effects (or failure of immunization) can occur.

When simultaneous vaccination for multiple different pathogens is required, each vaccine should be administered at sites drained by different lymph nodes, or, if possible, a combination vaccine should be used. In human medicine, simultaneous vaccination for multiple pathogens does not seem to interfere with immune responses to each component of the vaccine, or contribute to adverse effects (13-15), and manufacturers of veterinary vaccines must demonstrate that the protection that occurs for a specific pathogen after immunization with a combination product equals the protection that occurs when a vaccine for only that pathogen is given. However, successive parenteral administration of different


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Figure 1. Vaccines for feline respiratory pathogens can reduce the severity of clinical signs and, for some pathogens such as FHV-1, viral shedding, but do not completely prevent infection and disease.

attenuated live (but not inactivated) vaccines at intervals 3 to 14 days apart may interfere with immune responses. A minimum interval of 4 weeks is preferred for humans (11,16). Administration of vaccines to animals under anesthesia should be avoided because adverse reactions may be difficult or impossible to recognize in this situation. Note it is not necessary to re-administer an IN vaccine if the animal sneezes after administration. The site and route of administration, product, serial number, expiry date and individual that administered the vaccine should be recorded for each vaccine administered (2,4). Adhesive vaccine labels can facilitate this documentation.

Factors that determine vaccine immunogenicity

Vaccines rarely protect all individuals that receive a vaccine from infection and disease. Limited immunity following vaccination is especially likely for infections for which immunity after natural infection is partial or short-lived. For example, vaccines for canine and feline respiratory pathogens do not prevent disease but can reduce the prevalence and severity of disease, and (for some vaccines) the number of organisms shed ***(Figure 1)***.

The ability of a vaccine to induce an immune response depends not only on the target pathogen, vaccine composition, and the route of administration, but also host factors such as age, nutrition, genetics, pregnancy status, stress, concurrent infections, and immune status, including the presence or absence of passively acquired antibody. Some of these factors may also influence vaccine safety. Administration of vaccines to animals with moderate to severe illness should be delayed if possible until recovery has occurred because the immune response to the vaccine may be suboptimal.

Failure of immunization can result from an inadequate dose of antigen, and dividing a single vaccine dose for administration to a number of animals may lead to ineffective immunization. Immunogenicity and safety may also be compromised when a vaccine is administered using the incorrect route. Immunization may sometimes fail in the face of an overwhelming challenge dose.

One of the most common reasons for vaccine failure in dogs and cats is neutralization of vaccine antigen by MDA, which interferes with effective immunization ***(Figure 2)***. The amount of MDA in any one puppy or kitten cannot be predicted, as this varies depending on the titer of the dam and the amount of colostrum ingested after birth. As a result, repeated immunizations are required in order to increase the chance that successful immunization will occur soon after the decline of MDA titers to sufficiently low concentrations. Nevertheless, a window will always exist when MDA concentrations are high enough to interfere with immunization, but not sufficient to prevent natural infection; this "immunity gap" is known as the "window of susceptibility" or the "window of vulnerability". The use of recombinant vectored vaccines and intranasal vaccines have the potential to overcome the interference from MDA, especially as the mucosal immune system matures shortly after birth (17,18). Whenever possible, animals should be isolated until sufficient time has elapsed for proper immunization. For most parenteral and IN vaccines, this is one week (and at the minimum, 3 days) after inoculation.

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Figure 2. Although vaccines for CPV-2 can provide complete protection that lasts many years, if not for life, MDA commonly interferes with the immunization in puppies, as was the case for this 12-week old standard poodle puppy that developed clinical signs of parvovirus infection.

Use of antibody assays

For some vaccines, such as rabies, CDV, CPV and FPV, the presence of circulating antibodies correlates with protection. Thus, serologic tests have been used in dogs and cats to decide whether immunization is necessary or likely to be effective. Although tests that measure antibody responses have improved in recent years, caution is advised because different laboratories can report different values for the same serum specimen, and there is a lack of validated sensitivity and specificity for these assays. Furthermore, use of these assays may add significant cost and result in delayed immunization. In-practice tests are also available, and have the potential to overcome problems associated with laboratory quality control and delays in immunization. Although high titers are generally associated with greater protection, an animal with no titer may still be resistant to challenge because of cell mediated immunity. Conversely, an animal with a titer that is generally regarded as protective for a specific organism has the potential to develop disease following challenge, possibly because of overwhelming exposure or immunosuppression. Measurement of antibody titers may be considered for animals that have had previous adverse responses to vaccination, although this is usually not acceptable to public health authorities for determination of rabies immunity. The WSAVA has suggested that puppies be tested at least 2 weeks after the final puppy vaccine to decide whether further immunization for CDV or CPV is necessary (4). Negative titers should prompt additional immunization for these pups.

Adverse reactions

In order to produce protective immunity, a vaccine must stimulate a reaction in an animal at the site of injection and systemically. This may cause clinical signs. The most common adverse reactions to vaccines are transient fever and lethargy. In rare situations, severe adverse reactions, such as anaphylaxis, can occur. Veterinarians are encouraged to report adverse vaccine reactions to the manufacturer (2). In some countries, the drug company must then report details of the adverse reaction to the drug regulatory authorities. Other adverse reactions that can occur in response to vaccination include:

- Focal cutaneous reactions.
- Disease resulting from replication of micro-organisms within the vaccine, *e.g.* post-vaccinal distemper. This is uncommon when parenteral vaccines are used according to the manufacturer's recommendations. Immunization with live attenuated CDV and CPV vaccines is not recommended in pregnant animals, or puppies and kittens < 6 weeks of age (4). For animals that are chronically immunocompromised (such as cats with retrovirus infections), the use of inactivated vaccines is recommended if immunization is necessary, although the efficacy of these vaccines may be reduced in some of these animals. IN vaccines for respiratory pathogens may cause transient signs of upper respiratory disease in dogs and cats. Although proof is still lacking, there have been concerns that *Bordetella bronchiseptica* IN vaccines may cause respiratory disease in immunosuppressed humans that inhale the vaccine directly during administration, or contact vaccine organisms that are subsequently shed from immunized dogs (19,20). Inadvertent parenteral administration of the avirulent live *B. bronchiseptica* IN vaccine to

dogs can lead to severe injection site reactions and sometimes fatal hepatic necrosis (21).

- Sarcoma development at the injection site. Inactivated, adjuvanted vaccines (*e.g.* against FeLV and rabies) have been most commonly associated with these sarcomas in cats, but it remains unclear if the use of non-adjuvanted recombinant vaccines decreases the risk of sarcoma formation. Such that complete excision of these tumors can be achieved, it was recommended by the Vaccine-Associated Feline Sarcoma Task Force that rabies vaccines be administered as distally as possible on the right pelvic limb, and leukemia vaccines be administered as distally as possible on the left pelvic limb. Other core vaccines should be administered over the right shoulder. These recommendations were not adopted by the WSAVA, who

Table 1. AAHA, AAFP, and WSAVA-suggested regimes for immunization of pet dogs with core vaccines and vaccines most widely available for infectious respiratory disease and leptospirosis.

Vaccine	Initial immunization		Booster schedule	Comments
	Age ≤ 16 weeks	Age > 16 weeks		
CPV2 (A, SC) CDV (A, SC) CDV (R, SC) CAV2 (A, SC)	6-8 weeks of age, then every 3-4 weeks until no sooner than 14 to 16 weeks	Two doses, 3-4 weeks apart is recommended; however, one dose is protective.	1 year, then every 3 years thereafter	Core. CAV2 recommended for protection against CAV1.
Rabies (I, SC)	One dose as early as 3 months of age depending on local regulations	Single dose	1 year, then every 3 years thereafter with an approved product. Local regulations may dictate alternate protocols.	Core in endemic areas or where required by local regulations.
CPiV (A, SC)	6-8 weeks of age, then every 3-4 weeks until no sooner than 14 to 16 weeks	Single dose	Annual or within 6 months of boarding, and at least 1 week before boarding	Non-core. Use as a monovalent product or in combination with other non-core vaccines for annual boosters.
CPiV (A, IN)	One dose as early as 3 weeks of age; consider second dose 2-4 weeks later if initial immunization is at < 6 weeks of age	Single dose	See CPiV (A, SC)	Non-core. Available in combination with IN *B. bronchiseptica.*
***B. bronchiseptica* (I, SC)**	Two doses 3-4 weeks apart as early as 6 weeks of age	Two doses, 3-4 weeks apart	See CPiV (A, SC)	Non-core
***B. bronchiseptica* (CW, SC)**	Two doses 3-4 weeks apart starting at 8 weeks of age	Two doses, 4 weeks apart	See CPiV	Non-core
***B. bronchiseptica* (A, IN)**	One dose as early as 3 weeks of age	One dose	See CPiV	See CPiV (A, IN). Never administer SC.
Leptospira (I, SC)	Two doses 3-4 weeks apart starting at 12 weeks of age	Two doses, 3-4 weeks apart	Annual. Revaccinate one month before onset of the season if disease occurs seasonally.	Non-core, for dogs at risk of exposure. If available, a 4-serovar vaccine is preferred.

A, attenuated live; I, inactivated whole organism; SC, subcutaneous; IN, intranasal; R, recombinant; CW, cell wall antigen extract.

suggested that the skin of the lateral thorax and abdomen be used for immunization, and vaccination sites be rotated from year to year (4). Both groups recommended that the inter-scapular region be avoided for vaccine administration, because vaccine constituents may pool in this region and contribute to a chronic inflammatory response. Owners should monitor injection sites for 3 months after vaccines are administered; if a lump forms and increases in size 1 month after vaccination, or persists beyond 3 months, biopsy (and not aspiration cytology) is recommended.

Table 2. AAHA, AAFP, and WSAVA suggested regimes for immunization of pet cats with core, FeLV and *B. bronchiseptica* vaccines.

Vaccine	Initial immunization		Booster schedule	Comments
	≤ 16 weeks	> 16 weeks		
FPV (A, SC, I, SC)	6-8 weeks of age, then every 3-4 weeks until no sooner than 16 weeks	Two doses, 3-4 weeks apart	1 year, then every 3 years thereafter	Core. Protection after the 12-month booster is strong and may be lifelong. Cross-protects against infection from CPV variants.
FHV1 (A, SC, I, SC, A, IN)	See FPV	See FPV	See FPV. Annual revaccination may be indicated in contaminated environments.	Core. Does not provide complete protection.
FCV (A, SC, I, SC, A, IN)	See FPV	See FPV	See FHV1	See FHV1
Rabies (I, SC)	One dose as early as 3 months of age depending on local regulations	Single dose	1 year, then every 3 years thereafter with an approved product for 3-yearly immunization. Local regulations may dictate alternate protocols.	
Rabies (RC, SC)	Single dose as early as 8 weeks of age depending on local regulations	Single dose	Annual	
FeLV (RC, SC)	Two doses, 3-4 weeks apart starting at 8 weeks of age	Two doses, 3-4 weeks apart	1 year, then every 3 years thereafter when risk is ongoing.	Non-core.* Only for FeLV negative cats.
FeLV (RC, TD (USA), SC (elsewhere)	Two doses, 3-4 weeks apart starting at 8 weeks of age	Two doses, 3-4 weeks apart	Annual when risk is ongoing.**	See FeLV (I, SC)
***B. bronchiseptica* (A, IN)**	One dose as early as 8 weeks of age	One dose	Annual, but young cats are most at risk.	Non-core. Provides incomplete protection. Use in control programs in multiple cat households where infection is confirmed as endemic. Never administer parenterally.

A, attenuated live; I, inactivated whole organism; SC, subcutaneous; IN, intranasal; TD, transdermal; RC, recombinant canarypox.

* The AAFP highly recommends immunization of all kittens for FeLV.

**Annual vaccination of adult cats for FeLV is controversial. The ABCD and WSAVA suggest boosters every 2 to 3 years in view of the significant lower susceptibility of older cats, even with recombinant and subunit vaccines.

Conclusion

Suggested immunization schedules for individual pets and shelter animals that are based on recommendations provided by the AAHA, AAFP, and WSAVA are summarized in ***Tables 1*** and ***2***. To facilitate vaccine selection, currently available vaccines for dogs and cats have been divided by various taskforces into core vaccines, non-core vaccines, and those that are generally not recommended. Core vaccines are recommended for all animals with an unknown vaccination history. The diseases involved have significant morbidity and mortality and are widely distributed, and in general, vaccination results in relatively good protection from disease. All shelter animals should be immunized with core vaccines before entry to a shelter, or at the time of entry if immunization ahead of time is not possible. Canine core vaccines include vaccines for CPV, CDV, canine adenovirus (CAV), and rabies for countries where rabies is endemic. The core feline vaccines are those for feline herpesvirus 1 (FHV1), feline calicivirus (FCV), FPV and rabies. Non-core vaccines are optional vaccines that should be considered in light of the exposure risk of the animal, and include (for dogs) canine parainfluenza (CPi), *B. bronchiseptica, Leptospira spp.*, and *Borrelia burgdorferi*, and (for cats) FeLV, *Chlamydophila felis*, and *B. bronchiseptica*.

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Clinical epidemiology - vaccination perspectives

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Vaccination is an essential element of preventative and wellness care for pets. Recently, vaccination practices have come under public scrutiny for both pets and people, somewhat ironically because of the tremendous success of vaccination as a disease prevention strategy. Here we review the principles and foundation of vaccination strategy.

Why vaccinate?

The goals of vaccination are to prevent infectious disease, reduce severity (or shedding) of infection, minimize the risk for zoonotic disease transmission, and promote population immunity. Vaccination confers immunity to an individual without the risk and sequelae of natural infection, but also offers health benefits to the wider population; by immunizing a large proportion of individuals, the likelihood of exposure and infection for non-immunized animals is diminished - "herd immunity". The proportion of vaccinated individuals required to reduce susceptibility to a level where an epidemic cannot be sustained depends on various factors involving the population, the environment, and the agent, underscoring the relationship between the individual and the population at large.

Thanks to successful vaccination programs many countries have reduced or eliminated diseases such as polio, but consequently recent generations have no experience with many infectious diseases that were once common. There are parallels in veterinary medicine – young veterinarians may have never seen a clinical case of distemper or rabies.

Zoonoses

In the case of zoonoses vaccination can also protect family members from infection – for example rabies and leptospirosis can put pets and families at risk. Providing information on potential zoonotic disease transmission is an area where both veterinarians and physicians can partner with families; *e.g.* the One Health Initiative (www.onehealthinitiative.com) which was set up as a partnership between physicians and veterinarians in response to increasing concerns about the threat of emerging diseases worldwide (1). Future disease outbreaks pose significant threats to the health of humans and domesticated animals; approximately 75% of new emerging human diseases are zoonotic (2).

Adverse reactions

Administration of any exogenous medication involves risk, and the same holds true for vaccination administration; unexpected reactions or adverse events do occur. The benefit of therapy or vaccination needs to be weighed against the risk of adverse events. From population studies conducted using the Banfield database, we know that adverse reactions rates are low; 52 per 10,000 cats vaccinated (30 day follow-up) (3) and 39 per 10,000 dogs (3-days post-vaccination) (4). Young adult small-breed dogs and young adult neutered cats who received multiple vaccines were at greatest risk. For an owner, any adverse event is significant; quick and appropriate veterinary response is critical. Client education is especially important for pets known to be at higher risk.

Any vaccination should also consider how infrequent adverse events are when compared to disease prevalence. This is shown in ***Figure 1***, where the

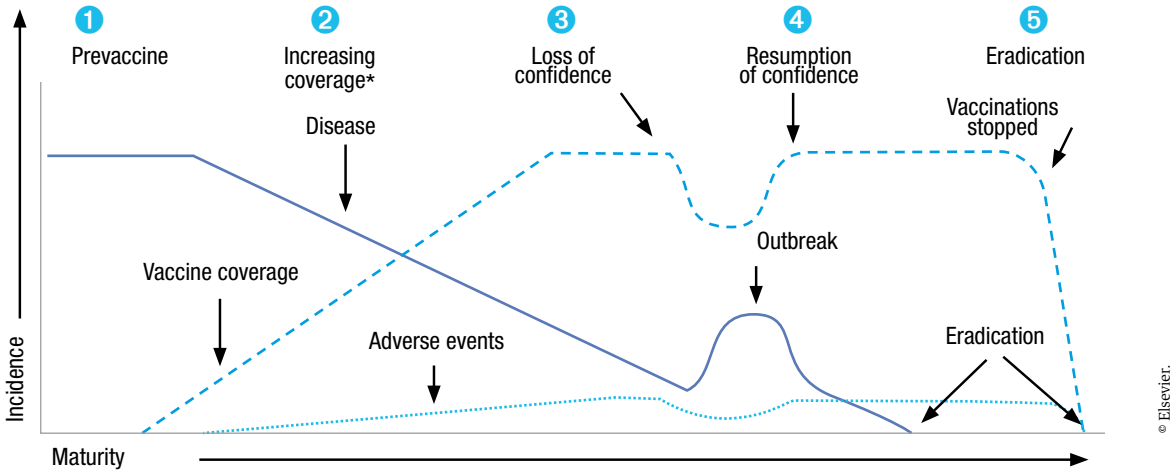

Figure 1. Potential stages in the evolution of an immunization program, showing the dynamics of the interaction between vaccine coverage, disease incidence and incidence of vaccine adverse events.

* Especially important for newly licensed vaccines or new indication of licensed vaccines.

rate of adverse events stays relatively constant, and is a small percentage of all individuals vaccinated (5). Over time, as a result of a vaccination program, the prevalence of disease decreases and the immunized proportion of the population increases. Risk of adverse events can be perceived to be higher since the number of infections is lower and as a percentage of infections, adverse events are a proportionately greater threat than they once were. A risk-benefit analysis weighs the benefits of immunity to the individual pet and family against the risk of adverse vaccine events. If a decision was taken not to vaccinate pets on a large scale this could shift the balance of disease prevalence and impact to the left as a greater proportion of individuals are susceptible and succumb to disease. Using current disease prevalence as an indicator for decision-making around individual vaccination protocols does not consider the overall perspective.

Conclusion - balancing science and practice

For the veterinarian, it is essential to provide balanced, compelling and accurate information on the importance of vaccines, especially given the public's concern around immunization in general. Offering clients the whole picture behind the rationale for vaccination is a good start, with an emphasis on vaccination as a critical part of the approach to wellness care. Because vaccination strategies have been so successful in prevention of infectious diseases, benefit may not always appear to outweigh risk, especially for a younger generation that has not experienced devastating major infectious disease outbreaks. This perception is misleading and can lead to new outbreaks of disease; recent outbreaks of human measles illustrate the vulnerability of this balance.

Global mobility of people and their pets means that there are fewer geographic boundaries today for disease – exposure may come in unexpected places at unexpected times. In addition to this mobility, there is increasing overlap of wildlife habitats with humans and domesticated animal populations. As the human population in the world surges, this becomes even more relevant as a source of exposure to zoonotic diseases. Veterinarians should therefore strive to educate their clients and encourage sensible vaccination policies at all times.

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Weight control and obesity in companion animals

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Introduction

Obesity is officially defined as a disease where excessive body fat has accumulated such that health may be adversely affected. The terms 'overweight' and 'obese' are used when the current weight of an animal exceeds the ideal by 15% (for dogs) or 30% (for cats). Recent studies have shown that approximately 40% of pets are overweight; obesity is now the most common medical disorder of companion animals and a major welfare concern, yet many veterinarians still do not treat it seriously, instead believing it to be a cosmetic issue. However, the condition is now known to predispose to a variety of clinical disorders as well as increased anesthetic risk and reduced life expectancy. In the UK, clinicians not only have an ethical obligation to manage and prevent the condition, they also have a legal obligation to do so, not least given recent high-profile cases where owners have been successfully prosecuted for not adequately addressing obesity in their pets. This article will discuss the causes of obesity and its consequences, and then focus on how the condition can be managed and prevented.

KEY POINTS

- Obesity should now be considered as a medical disorder, not just a nutritional disorder, and is a chronic, incurable disease.
- The risk factors associated with obesity rarely disappear; because of this, management and prevention require long-term energy control.
- A number of disease associations are recognized in both dogs and cats, and there is good evidence that disease status improves with weight loss.
- Key factors associated with successful weight loss include the type of diet, how it is measured out and fed, and how the program is monitored.
- Continuing to feed a weight management diet long-term is a key strategy in dogs for preventing rebound. This may well also be beneficial for cats.

Risk factors for obesity

Obesity develops when energy intake exceeds expenditure for a prolonged period, and there are various factors that contribute to this process ***(Table 1)***. Some diseases can predispose to obesity such as some endocrine disorders (*e.g.* hypothyroidism in dogs and hyperadrenocorticism in dogs and cats). However, relative to the frequency of obesity, these cases are uncommon (*e.g.* 0.2% prevalence for hypothyroidism, with less than half of affected dogs become obese) and the majority of overweight dogs seen in practice will have simple obesity.

Genetics are known to be important in the development of human obesity, and genetic influences for canine obesity are suggested by known breed predispositions (1). Neutering predisposes to obesity in both dogs and cats, and most recent studies suggest that the effect is due to an alteration in behavior, leading to increased food intake and decreased activity (2). Gender is also a predisposing factor, with female dogs and male cats over-represented. Other

Table 1. Risk factors for obesity (1,6).

Iatrogenic
- Medical: drugs causing polyphagia *e.g.* steroids, anticonvulsant drug
- Surgical: bilateral thyroidectomy to treat hyperthyroidism can, very occasionally, cause hypothyroidism in cats.

Animal factors
- Breed *e.g.* Labrador retriever, cavalier King Charles spaniel, cocker spaniel, beagle
- Middle age in both dogs and cats
- Sex and neutering
  - Neutering in both dogs and cats
  - Female dogs
  - Male cats

Lifestyle factors
- Indoor lifestyle in dogs
- Apartment dwelling in cats
- Inactivity in dogs

Owner factors
- Older owners
- Human obesity
- Female gender
- Lower income (dog owners)
- Close owner-pet relationship

Diet factors
- Dogs
  - Number of meals and snacks fed
  - Feeding of table scraps
  - Dog present when owners prepare or consume their own food
- Cats
  - Feeding food *ad lib*
  - Feeding fresh meat or table scraps

Endocrine disease
- Hypothyroidism
- Hyperadrenocorticism

Behavioral factors
- Dogs
  - Over-humanization
  - Feeding behavior
  - Owner shows less interest in preventive healthcare for pet.
- Cats
  - Close owner-pet relationship
  - Over-humanization
  - Substitute for human companionship
  - Feeding behavior
  - Owner shows less interest in preventive healthcare for pet.
  - Cat is anxious or depressed.
  - Owner has less play time with cat and misinterprets play behavior.
  - Owner misinterpretation of feeding behavior

recognized associations in dogs include indoor lifestyle, inactivity, middle age, and dietary factors.

Owners commonly misinterpret feline feeding behavior and this may also be a causal factor in undesired weight gain. In the wild, cats are trickle feeders, typically consuming many (10-15) small meals each day (3). Despite this, many owners choose to feed their cats in 2-3 large meals per day. Furthermore, cats do not require social interaction during feeding times so, when the cat initiates contact, owners mistakenly assume that they are hungry and are asking for food. Nevertheless, if food is provided under such circumstances, the cat will learn to initiate contact to receive a food reward. Offering either large volumes or highly energy-dense foods can then predispose to excessive food intake and obesity. Another common misconception is that play is only of interest to juvenile cats; in fact it is necessary throughout life. Dog owners are usually conditioned to provide regular exercise through both walks and play; in contrast, options for increasing activity for cats are largely limited to stimulating play, but most owners do not engage in play sessions with their pets.

Consequences of obesity

The medical importance of obesity lies in its effects on lifespan and on predisposing to other diseases; obese humans tend to die younger, and suffer more from various pathological conditions. In a similar manner, obesity is detrimental to the health and well-being of animals ***(Table 2)***.

Quality and quantity of life

Energy restriction without malnutrition can increase longevity in a wide variety of species. This may be due to adaptation of neuroendocrine systems, prevention of inflammation, hormetic response (a process whereby a low-intensity stressor increases resistance to a more intense stressor), and protection against damage from oxidative stress. One study showed that colony-based dogs fed *ad lib* lifelong were overweight (mean body condition score (BCS) 6.8/9) compared with energy-restricted dogs (mean BCS 4.5/9), and lifespan was significantly shorter (by a median of 1.8 years) (4). Such findings provide compelling reasons why owners should strive to maintain their pets in an ideal body composition throughout their lives, in addition to reducing any known or proposed obesity-associated diseases. There is also emerging evidence that quality of life is reduced in obese dogs, but improves after weight loss (5).

Diseases associated with obesity

Obesity is reported to be a risk factor for a variety of

disorders ***(Table 2)***. Both cats and dogs are predisposed to diabetes mellitus (1,6). Recent studies in both species have demonstrated that the body fat % correlates with the degree of insulin resistance, and insulin sensitivity is improved significantly upon successful weight loss (7,8). Obesity is a major risk factor for orthopedic diseases in dogs, with a greater prevalence of both traumatic and degenerative orthopedic disorders in obese animals, *e.g.* cranial cruciate ligament rupture, intervertebral disc disease. There are also reported associations with hip dysplasia and osteoarthritis, and weight reduction can lead to a substantial improvement in the degree of lameness shown in dogs with hip osteoarthritis (9). Obesity may also be a risk factor for orthopedic disease in cats, with one study suggesting that obese cats were five times more likely to limp than cats of normal body condition (10).

In dogs, excessive adipose tissue can have effects on respiratory system function (11); this may explain the anecdotal links between obesity and certain respiratory diseases in dogs, most notably tracheal collapse, laryngeal paralysis and brachycephalic airway obstruction syndrome. An association between obesity and some cases of canine urethral sphincter

Table 2. Reported clinical disease associations in canine and feline obesity.

Disease category	**Species**	
	Cat	**Dog**
Orthopedic	Lameness*	Cruciate ligament disease Osteoarthritis Humeral condylar fractures Intervertebral disc disease Hip dysplasia
Endocrine	Diabetes mellitus	Hypothyroidism Hyperadrenocorticism Diabetes mellitus **
Lipid disorders	Hepatic lipidosis	Hyperlipidemia
Alimentary	Oral cavity disease* Gastrointestinal disease* Diarrhea*	Oral cavity disease Pancreatitis
Urogenital	Urinary tract disease*	Urinary tract disease Urethral sphincter mechanism incompetence Calcium oxalate urolithiasis Transitional cell carcinoma Glomerular disease Dystocia
Cardiorespiratory	---	Tracheal collapse Effect on cardiac function Expiratory airway dysfunction Hypertension Portal vein thrombosis Myocardial hypoxia
Integument	Increased risk of dermatoses*	---
Oncological	Increased neoplasia risk*	Variable neoplasia risk * Transitional cell carcinoma
Other	None reported	Increased anesthetic risk Decreased heat tolerance

* Association identified in epidemiological studies, with a number of diseases represented.
** Epidemiological association identified, but mechanism unclear.

mechanism incompetence has been reported, whilst obese cats have been shown to be at increased risk of oral cavity disease, dermatological disorders and diarrhea (6). However, the reasons for such associations are not clear.

Finally, some epidemiological studies in both cats and dogs have reported an increased risk of neoplasia in animals that are obese (1,6) although these studies did not assess the different types of neoplasia. Excess weight increases the risk of developing transitional cell carcinoma of the bladder, whilst some (but not all) studies have reported an association between canine mammary carcinoma and obesity (12,13).

The cost of obesity

One recent study found that medical costs were 17% greater for owners of overweight dogs than owners of dogs of normal weight, whilst owners of overweight cats spent 36% more on diagnostic procedures and 53% more on surgical procedures than owners of cats of normal weight (Banfield Pet Hospital, personal communication).

Management of obesity

Returning obese animals to optimal body condition using weight management strategies can improve factors such as mobility, insulin sensitivity (7), and quality of life (5). However, a major misconception is that weight loss is easy to achieve in companion animals. Many veterinarians rather simplistically assume that successful weight loss is just a case of getting the pet "to eat less and exercise more", compounded by the fact that many studies on obesity involve colony animals where overfeeding is used to induce obesity artificially. In such a setting, treatment strategies are highly successful in rapidly returning dogs to optimal body weight, suggesting that the process is straightforward and always works. However, for several reasons real life weight loss is more difficult for obese dogs with an owner 'attached'. Firstly, pet dogs are typically more overweight than obesity-induced colony dogs. Secondly, only ~50% of animals commencing a weight loss program actually complete it (14). Thirdly, even in dogs that successfully reach ideal weight, weight loss progresses slowly (typically <1% per week) and requires more aggressive energy restriction than in experimental obesity models (15-17). Further, subsequent rebound is a common problem; almost half of the obese dogs that reach their target will regain some weight (18). Therefore only a minority of obese pet dogs undergoing weight loss are successful at losing weight and then keeping it off.

This may seem a depressing scenario, but if obesity is regarded as a chronic, insidious, incurable disease, these outcomes are not unexpected. As with other chronic diseases, success should not just be about 'achieving remission' (*e.g.* reaching target weight), but also 'maintaining remission' (*e.g.* preventing rebound long-term), and 'reducing morbidity' (*e.g.* decreasing severity of signs caused by any associated diseases and increasing quality of life).

Bariatric surgery (the most successful approach for severe human obesity) is not considered ethically justifiable in companion animals. Dietary therapy remains the most common approach to obesity management, although two drugs are licensed in some countries for the treatment of canine (but not feline) weight loss. Whether diet or drug therapy forms the basis for weight loss, long-term success can only come from altering lifestyle permanently to prevent rebound.

Dietary management

A purpose-formulated diet for feeding during weight loss is recommended. Such diets are restricted in fat and caloric density, whilst being supplemented in protein and micronutrients. This ensures that deficiency states do not develop when energy is restricted. In dogs, using a weight loss diet that combines increased amounts of both protein and fiber (relative to energy content) has a greater effect on satiety than diets supplemented in either protein or fiber alone (19). Further, such a diet can improve the outcome of a weight management program by increasing both rate of weight loss and loss of body fat mass (17). However, such a combination is not optimal for cats since dietary protein level is a major factor driving food intake in this species (20). Instead, moderately high protein level combined with fiber seems to be optimal in terms of satiety (20). Dietary supplementation of L-carnitine may help maintain lean tissue during weight loss, possibly due to enhanced fatty acid oxidation and energy availability for protein synthesis during times of need.

Whatever the type of diet chosen, the level of energy allocation should be calculated correctly, and will

vary with signalment, other factors (*e.g.* ability to exercise, concurrent illness etc), and the type of diet. Note energy calculations ***(Table 3)*** are usually based upon the target body weight and not the current weight. The initial allocation is only a starting point, and often requires modification during the weight loss program, usually by decreasing the amount given. Weighing the daily food ration on electronic weigh scales is strongly recommended, since other methods of determining the amount to feed (*e.g.* measuring cups) are unreliable (21). If possible, no additional food should be given by the owners or scavenged by the dog. Healthy treats may be allowed, provided that they are taken into consideration in the overall energy allocation, and provide <5% of total daily requirements. Liquids (*e.g.* milk) and food used to facilitate oral administration of medications can also be a source of significant caloric intake, and owners should be discouraged from feeding these.

Recent studies have shown that the mean energy requirement for weight loss in dogs is 57 Kcal/kg of metabolic body weight ($kg^{0.75}$) at target (15,17), whilst, to ensure steady weight loss in cats, an average daily intake of 32 Kcal/kg of target body weight should be fed (22). With this degree of restriction, the mean rate of weight loss is 0.8% body weight/week for both species. Close monitoring is required and energy intake must be reduced progressively to ensure continued weight loss. Using a diet supplemented in protein (relative to energy content) is important since, although weight loss is not more rapid, the amount of lean tissue lost is minimized.

Table 3. Method of estimating target weight.

Recent work has shown that each point between 5 and 9 on the 9-point BCS scale approximates to 10% of excess body weight (calculated using starting body weight) (27). Therefore, by using a simple equation, target weight can be estimated e.g.

Current weight = 50 kg and current BCS = 9/9 (~ 40% overweight)
Then the ideal weight = 50 kg – (50 x 40/100) = 30 kg.

Note such calculations may provide a reasonable guide but can over- or under-estimate target weight and thus the appropriate end-point. Therefore pets should be closely monitored during weight loss and changes made to the plan as required.

Pharmaceutical therapy

Two pharmaceutical products are available in some countries for use in dogs only. Both drugs have a local effect within enterocytes to inhibit microsomal triglyceride transfer proteins. Blocking these molecules halts the assembly and release of lipo-protein particles into the bloodstream, and caloric intake is decreased, partly by decreasing lipid absorption, but predominantly by reducing appetite. Such drugs may particularly be of benefit where negative behaviors associated with dietary restriction (*e.g.* increased begging and scavenging) lead to poor owner compliance.

Dirlotapide can be used continuously for up to 12 months. Weight loss occurs at a steady rate (0.75% per week on average), but periodic increases in dose are required to maintain weight loss. Significant amounts of weight loss have been demonstrated in clinical trials (23). Mitratapide has a similar mechanism of action to dirlotapide, but rather than long-term continuous dosing, it is used short-term (two three-week periods separated by a two-week treatment break) and in conjunction with dietary management and behavioral modification.

Side effects, usually gastrointestinal (*e.g.* vomiting and diarrhea), can occur with both drugs in ~ 20% of patients (23). If owners are forewarned about this complication, compliance is usually better. Whilst these drugs provide an easy avenue for weight loss, appetite returns rapidly after discontinuation of therapy; unless other strategies (feeding and behavioral) are implemented, a rapid and predictable rebound in body weight occurs. Although perhaps counter-intuitive, concurrent use of medication and dietary energy restriction does not improve outcome, probably because such drugs are less potent than when a diet with a normal fat content is fed.

Lifestyle management

Changing owner behavior is key to success with both weight loss and avoiding rebound. This is dictated by the clinician's ability to convince the owner to comply with the weight loss strategy and

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Figure 1. Stimulating activity in cats using a fishing rod toy. Such toys are good because they create rapid unpredictable movements, mimicking prey behavior in the wild.

adopt responsible pet-ownership practices, such as avoiding overfeeding, using treats sensibly, and increasing their pet's activity. Whilst such strategies are well known, the challenge for the veterinarian is to communicate these ideas effectively to the client, and provide counseling such that, when good habits are adopted, they are maintained.

Increasing physical activity promotes fat loss, and may help to preserve lean tissue during weight loss. The exact program must be tailored to the individual, and take account of any concurrent medical concerns. The recommended type of physical activity will vary depending upon the individual but might include controlled exercise (*e.g.* lead walking), non-restricted exercise (*e.g.* activity off-lead), swimming and hydrotherapy, treadmill exercise, increased play activity and increasing movement during feeding. Recent work has shown that incorporating an organized exercise regimen in a conventional canine weight management program can improve the rate of weight loss (*e.g.* 1.5% *vs.* 0.8% of starting body weight per week) (24).

Cats can be encouraged to exercise by increasing play activity with toys ***(Figure 1)***. In addition, both dogs and cats can also be required to 'work' for their food by moving the food bowl between rooms prior to feeding, or by the use of feeding toys.

The overall contribution of energy expenditure through increased activity to the altered energy balance required to induce weight loss is relatively minor compared with energy restriction through dietary or pharmaceutical means, but is still a vital component of the program since it has additional benefits, including:

- Maintaining muscle mass and resting metabolic rate.
- Improving mobility.
- Providing positive benefits for the cardiovascular system.
- Enhancing the pet/owner bond by developing a relationship based on play rather than on food.
- Providing mental stimulation and improving welfare and quality of life.
- Improving compliance with and outcome of the weight management program as a whole.

Monitoring the weight loss regimen

In addition to the above strategies, it is essential that the whole weight reduction regimen be supervised. This is labor-intensive, requires some degree of expertise and training in owner counseling, and often requires a dedicated member of staff. Patient progress must be closely monitored, particularly during the initial period, since this is when problems are most likely to be encountered. Initially, rechecks every 2 weeks are recommended, but the interval can be extended if consistent weight loss is achieved. If revisits occur less frequently than every 4 weeks, compliance may slip. These appointments provide an opportunity to verify compliance, deal with any owner concerns (*e.g.* side effects of pharmaceuticals, begging behavior), and to provide feedback, encouragement and support.

Body weight is the principal outcome measure, and is used to determine changes to the regimen. Using the same set of electronic weigh scales will minimize variability amongst measurements. Measuring thoracic and abdominal circumference ***(Figure 2)*** can be an additional means of emphasizing progress in terms that the owner will understand. Periodic photographs, preferably taken in a standardized manner, also provide an excellent visual demonstration of success ***(Figure 3)***. Between visits, owners should be encouraged to record food intake and

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Figure 2. Using a tape measure to measure thoracic (a) and abdominal (b) girth in an obese domestic shorthair cat.

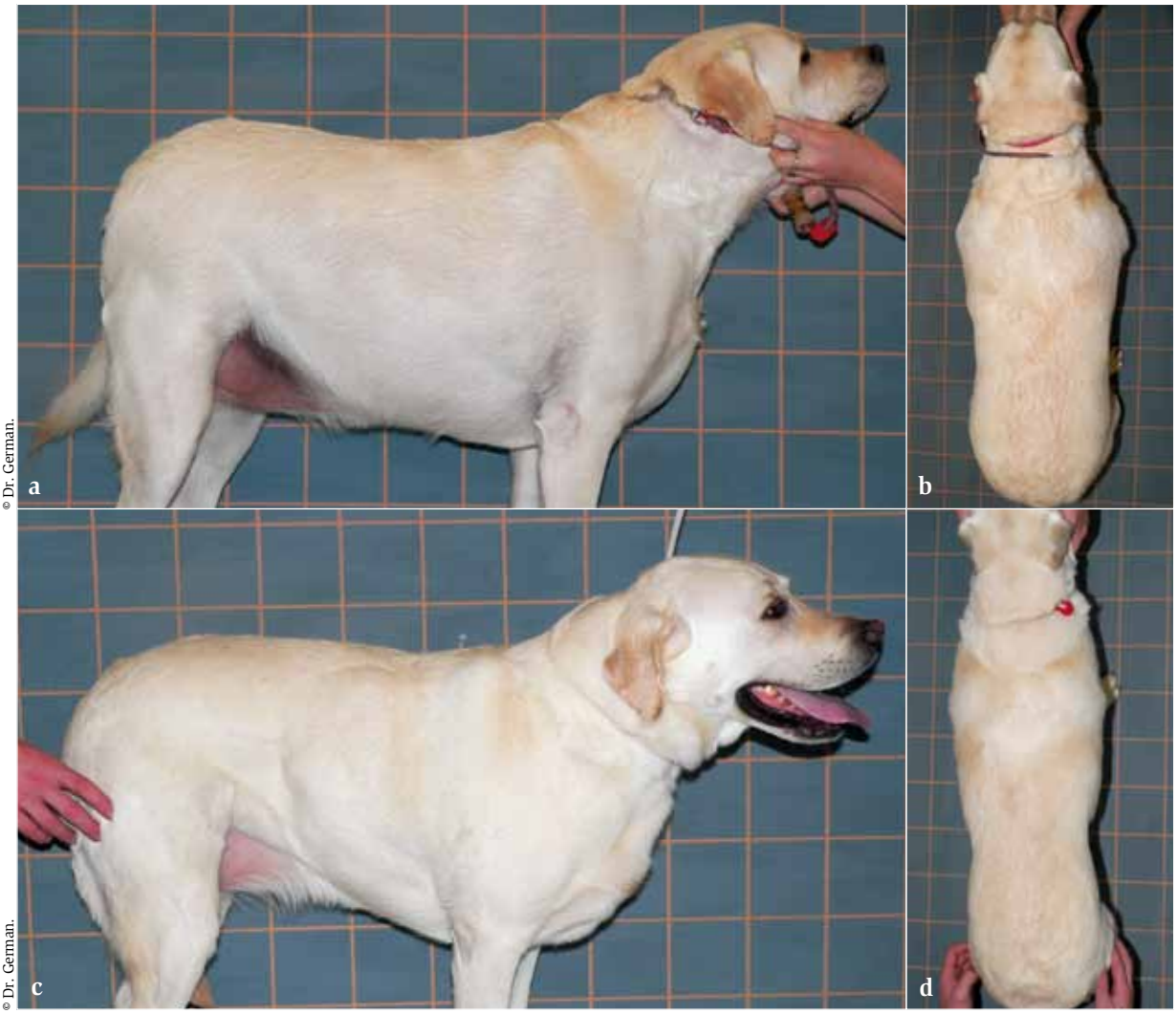

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Figure 3 a & b - Photographs of an obese 7-year-old neutered female Golden Labrador, prior to weight loss. The dog weighed 49 kg, BCS was 9/9, and body fat percentage was 51%. ***c & d*** Photographs of the same dog, 268 days later, after successful weight loss on a high protein high fiber diet. Bodyweight had decreased to 33.6 kg, BCS was 5/9, and body fat percentage was 36%. Total weight lost was 31% of starting bodyweight, at a rate of 0.8%/week.

exercise in a diary, and this information can also be reviewed. Owner motivation is the key to a successful outcome and incentives, such as 'slimmer of the month' awards or achievement certificates are useful motivational tools. Pro-active follow-up with phone calls is an excellent way of checking on progress, enhancing compliance and addressing any problems as early as possible.

It is essential to monitor bodyweight after the ideal weight has been achieved to ensure that there is no rebound (23,25). Regain in weight is probably because maintenance energy requirements after weight loss are low (26). In dogs, a key factor that may help to reduce the rebound effect is continuing to feed the diet used in weight loss during the maintenance period (18).

Table 4. Key principles for obesity prevention.

Intervene as soon as possible

- Targeting younger dogs and cats will maximize the benefits - longevity and improved quality of life.
- Early intervention avoids or minimizes the time spent in the obese state and hence the risk of developing associated diseases.
- Intervening early may mean that development of "bad habits"(inactivity, begging behavior etc) can be avoided.
- As part of this approach, weigh the pet and perform a BCS at every clinic visit.

Target neutered animals to prevent weight gain

- Forewarn owners of the risk of weight gain after neutering and the need to reduce caloric intake.
- Weigh animal after neutering to identify weight gain (*e.g.* 2, 8, 26 and 52 weeks post-op).
- Be alert to weight gain in middle-aged pets; monitor these animals regularly.

Target new pet owners who may not be aware of the concerns over obesity

- Owners are often highly motivated and receptive to advice.
- Owners may have received bad advice from elsewhere (*e.g.* breeders, friends).

Promote awareness of energy balance (see Table 5)

Table 5. Awareness of energy balance.

Regulate food intake

- A feeding guide is only a 'guide' – tailor individual intake depending upon response (*e.g.* weight gain or loss).
- Feed a balanced diet appropriate to the life-stage of the pet.
- Consider measuring daily food ration, especially when feeding kibble diets.
- Minimize the feeding of supplemental food – see below.
- Caution when switching brands (adapt the intake to the diet).
- Care with measuring cups which can be unreliable.
- Consider maintaining a diary record in an animal prone to weight gain.
- In multi-pet households, either feed animals separately or supervise feeding to insure individual needs are met, whilst excess intake is avoided.

The need for regular activity

- Walking if fit (dogs).
- Hydrotherapy in dogs with orthopedic disease.
- Play sessions (cats and dogs).
- Encouraging activity at meal times (cats and dogs).
- Spread kibble over large area.
- Move food bowl and encourage pet to follow.
- Use a food puzzle.
- Use kibble to stimulate play sessions.
- Adapt food intake to energy expenditure
- Feed more on more active days (*e.g.* weekend, holidays) and reduce food intake for inactive periods (*e.g.* weekdays for working owners, during bad weather).
- Adapt food intake to periods of illness (*e.g.* lameness when activity is reduced).
- Reduce food intake when the pet is kenneled.

Weigh and perform a BCS regularly to ensure that energy balance is maintained.

Responsible 'rewarding' of pets

- Educate all owners and friends.
- Only use healthy treats.
- If necessary, set aside a portion ofthe daily ration for treats.
- Take account of the treats in daily energy calculation.
- Minimize the size of the treat (it is the act of giving which is important, not the amount!).
- Consider other methods of reward *e.g.* play session, walk, attention.

Conclusion

Prevention is better than cure and so the health and welfare of pets will be more markedly improved by preventing the development of obesity, rather than by treating it once it has developed. Veterinarians are trusted by clients and therefore in a unique position to provide education about the dangers of obesity in their pets; a proactive approach to obesity, offering adequate client education from the first puppy vaccination visit throughout life, especially in susceptible breeds, is recommended, and a strategy for obesity prevention is shown in ***Table 4***. Advocating a healthy lifestyle for all pets, including raising awareness of energy balance ***(Table 5)*** is key to this, and ideally will involve all practice staff to successfully promote these concepts.

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Dental plaque control

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It is universally accepted that daily plaque control is central to the prevention of periodontal disease in dogs and cats. Owners can find it difficult to master the techniques required to brush, wipe or rub plaque away from the teeth; how to open the pet's mouth, as well as how and where to apply the plaque-cleaning device, can often also cause confusion.

Tooth-brushing

Daily tooth-brushing is the gold standard of plaque control. When performed correctly the toothbrush bristles enter into the gingival sulcus, removing harmful plaque. Application of poultry flavored toothpaste is acceptable to most dogs.

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Gently grasp the animal's head with both hands and, having applied a liberal amount of toothpaste to the brush, use one hand to gently pull the upper lip upwards, exposing the teeth; press the brush to the outward surfaces of the upper tooth/gum interface in a back and forth motion.

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Then apply the brush to the outward surfaces of the lower teeth. Switch hands to expose the left cheek teeth and repeat the process. The incisors and canines should also be brushed, applying the toothbrush bristles to the area where the lower canine meets the gum line. Note the proper application of the toothbrush bristles under the gum line.

Dental wipes

Perhaps the easiest way to control plaque is through the mechanical and chemical effect of daily wipes. Pads impregnated with either chlorhexidine or sodium hexametaphosphate can be effective in controlling plaque and calculus when used on the buccal surfaces of the upper and lower teeth.

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With the head gently raised at a 45° angle, the left fingers are used to expose the front teeth and gums; the pad is rubbed against the teeth, working around the mouth to clean the cheek teeth, incisors and canines in turn.

Cotton buds

Using cotton buds as part of the routine carries the advantage of site-specific plaque removal. Hold a large cotton bud as you would a pen and gently rub the plaque away from the area of interest. This technique may be especially useful for cats.

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Gently hold the head with two hands and lift the head at a 45° angle. Use the left fingers to open the lips and, holding the cotton bud in the right hand, apply to the tooth surface to remove plaque.

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For a cat, gently grasp the head with both hands. Using the left index finger and thumb, gently raise the right lip to expose the front and cheek teeth; grasping the bud in the right hand, apply the tip to the area of plaque accumulation and gently rub to remove.