| To: | Maria Kostrencich | From: | Cathie Turner |
|------|--|--------|---------------|
| Fax: | 12139781079 | Pages: | 13 |
| Re: | Oppose File Item # 07-1212 Spay/Neuter Ordinance) | Date: | 1/31/2008 |

X Urgent For Review Please Comment Please Reply For Information

• Comments:

Honorable City Council Member:

I respectfully urge you to vote no on File Item # 07-1212 (Spay/Neuter Ordinance). Spay/neuter has adverse health risks that must be weighed against its benefits, on a case by case basis. One size does not fit all. Please see the attached report. Thank you.

Cathie Turner Concerned Dog Owners of California

Long-Term Health Risks and Benefits Associated with Spay / Neuter in Dogs Laura J. Sanborn, M.S.

May 14, 2007

Precis

At some point, most of us with an interest in dogs will have to consider whether or not to spay / neuter our pet. Tradition holds that the benefits of doing so at an early age outweigh the risks. Often, tradition holds sway in the decision-making process even after countervailing evidence has accumulated.

Ms Sanborn has reviewed the veterinary medical literature in an exhaustive and scholarly treatise, attempting to unravel the complexities of the subject. More than 50 peer-reviewed papers were examined to assess the health impacts of spay / neuter in female and male dogs, respectively. One cannot ignore the findings of increased risk from osteosarcoma, hemangiosarcoma, hypothyroidism, and other less frequently occurring diseases associated with neutering male dogs. It would be irresponsible of the veterinary profession and the pet owning community to fail to weigh the relative costs and benefits of neutering on the animal's health and well-being. The decision for females may be more complex, further emphasizing the need for individualized veterinary medical decisions, not standard operating procedures for all patients.

No sweeping generalizations are implied in this review. Rather, the author asks us to consider all the health and disease information available as individual animals are evaluated. Then, the best decisions should be made accounting for gender, age, breed, and even the specific conditions under which the long-term care, housing and training of the animal will occur.

This important review will help veterinary medical care providers as well as pet owners make informed decisions. Who could ask for more?

Larry S. Katz, PhD Associate Professor and Chair Animal Sciences Rutgers University New Brunswick, NJ 08901

INTRODUCTION

Dog owners in America are frequently advised to spay/neuter their dogs for health reasons. A number of health benefits are cited, yet evidence is usually not cited to support the alleged health benefits.

When discussing the health impacts of spay/neuter, health risks are often not mentioned. At times, some risks are mentioned, but the most severe risks usually are not.

This article is an attempt to summarize the long-term health risks and benefits associated with spay/neuter in dogs that can be found in the veterinary medical literature. This article will not discuss the impact of spay/neuter on population control, or the impact of spay/neuter on behavior.

Nearly all of the health risks and benefits summarized in this article are findings from retrospective epidemiological research studies of dogs, which examine potential associations by looking backwards in time. A few are from prospective research studies, which examine potential associations by looking forward in time.

SUMMARY

An objective reading of the veterinary medical literature reveals a complex situation with respect to the long-term health risks and benefits associated with spay/neuter in dogs. The evidence shows that spay/neuter

correlates with both positive AND adverse health effects in dogs. It also suggests how much we really do not yet understand about this subject.

On balance, it appears that no compelling case can be made for neutering most male dogs, especially immature male dogs, in order to prevent future health problems. The number of health problems associated with neutering may exceed the associated health benefits in most cases.

On the positive side, neutering male dogs

- eliminates the small risk (probably <1%) of dying from testicular cancer
- reduces the risk of non-cancerous prostate disorders
- · reduces the risk of perianal fistulas
- may possibly reduce the risk of diabetes (data inconclusive)

On the negative side, neutering male dogs

- if done before 1 year of age, significantly increases the risk of osteosarcoma (bone cancer); this is a common cancer in medium/large and larger breeds with a poor prognosis.
- increases the risk of cardiac hemangiosarcoma by a factor of 1.6
- triples the risk of hypothyroidism
- increases the risk of progressive geriatric cognitive impairment
- triples the risk of obesity, a common health problem in dogs with many associated health problems
- quadruples the small risk (<0.6%) of prostate cancer
- doubles the small risk (<1%) of urinary tract cancers
- increases the risk of orthopedic disorders
- increases the risk of adverse reactions to vaccinations

For female dogs, the situation is more complex. The number of health benefits associated with spaying may exceed the associated health problems in some (not all) cases. On balance, whether spaying improves the odds of overall good health or degrades them probably depends on the age of the female dog and the relative risk of various diseases in the different breeds.

On the positive side, spaying female dogs

- if done before 2.5 years of age, greatly reduces the risk of mammary tumors, the most common malignant tumors in female dogs
- nearly eliminates the risk of pyometra, which otherwise would affect about 23% of intact female dogs; pyometra kills about 1% of intact female dogs
- reduces the risk of perianal fistulas
- removes the very small risk (≤0.5%) from uterine, cervical, and ovarian tumors

On the negative side, spaying female dogs

- if done before 1 year of age, significantly increases the risk of osteosarcoma (bone cancer); this is a common cancer in larger breeds with a poor prognosis
- increases the risk of splenic hemangiosarcoma by a factor of 2.2 and cardiac hemangiosarcoma by a factor of >5; this is a common cancer and major cause of death in some breeds
- triples the risk of hypothyroidism
- increases the risk of obesity by a factor of 1.6-2, a common health problem in dogs with many associated health problems
- causes urinary "spay incontinence" in 4-20% of female dogs
- increases the risk of persistent or recurring urinary tract infections by a factor of 3-4
- increases the risk of recessed vulva, vaginal dermatitis, and vaginitis, especially for female dogs spayed before puberty
- doubles the small risk (<1%) of urinary tract tumors
- · increases the risk of orthopedic disorders
- increases the risk of adverse reactions to vaccinations

One thing is clear – much of the spay/neuter information that is available to the public is unbalanced and contains claims that are exaggerated or unsupported by evidence. Rather than helping to educate pet

owners, much of it has contributed to common misunderstandings about the health risks and benefits associated of spay/neuter in dogs.

The traditional spay/neuter age of six months as well as the modern practice of pediatric spay/neuter appear to predispose dogs to health risks that could otherwise be avoided by waiting until the dog is physically mature, or perhaps in the case of many male dogs, foregoing it altogether unless medically necessary.

The balance of long-term health risks and benefits of spay/neuter will vary from one dog to the next. Breed, age, and gender are variables that must be taken into consideration in conjunction with non-medical factors for each individual dog. Across-the-board recommendations for all pet dogs do not appear to be supportable from findings in the veterinary medical literature.

FINDINGS FROM STUDIES

This section summarizes the diseases or conditions that have been studied with respect to spay/neuter in dogs.

Complications from Spay/Neuter Surgery

All surgery incurs some risk of complications, including adverse reactions to anesthesia, hemorrhage, inflammation, infection, etc. Complications include only immediate and near term impacts that are clearly linked to the surgery, not to longer term impacts that can only be assessed by research studies.

At one veterinary teaching hospital where complications were tracked, the rates of intraoperative, postoperative and total complications were 6.3%, 14.1% and 20.6%, respectively as a result of spaying female dogs¹. Other studies found a rate of total complications from spaying of 17.7%² and 23%³. A study of Canadian veterinary private practitioners found complication rates of 22% and 19% for spaying female dogs and neutering male dogs, respectively⁴.

Serious complications such as infections, abscesses, rupture of the surgical wound, and chewed out sutures were reported at a 1-4% frequency, with spay and castration surgeries accounting for 90% and 10% of these complications, respectively.⁴

The death rate due to complications from spay/neuter is low, at around 0.1%2.

Prostate Cancer

Much of the spay/neuter information available to the public asserts that neutering will reduce or eliminate the risk that male dogs develop prostate cancer. This would not be an unreasonable assumption, given that prostate cancer in humans is linked to testosterone. But the evidence in dogs does not support this claim. In fact, the strongest evidence suggests just the opposite.

There have been several conflicting epidemiological studies over the years that found either an increased risk or a decreased risk of prostate cancer in neutered dogs. These studies did not utilize control populations, rendering these results at best difficult to interpret. This may partially explain the conflicting results.

More recently, two retrospective studies were conducted that did utilize control populations. One of these studies involved a dog population in Europe⁵ and the other involved a dog population in America⁶. Both studies found that neutered male dogs have a four times *higher* risk of prostate cancer than intact dogs.

Based on their results, the researchers suggest a cause-and-effect relationship: "this suggests that castration does not initiate the development of prostatic carcinoma in the dog, but does favor tumor progression" and also "Our study found that most canine prostate cancers are of ductal/urothelial origin....The relatively low incidence of prostate cancer in intact dogs may suggest that testicular hormones

are in fact protective against ductal/urothelial prostatic carcinoma, or may have indirect effects on cancer development by changing the environment in the prostate."

This needs to be put in perspective. Unlike the situation in humans, prostate cancer is uncommon in dogs. Given an incidence of prostate cancer in dogs of less than 0.6% from necropsy studies⁷, it is difficult to see that the risk of prostate cancer should factor heavily into most neutering decisions. There is evidence for an increased risk of prostate cancer in at least one breed (Bouviers)⁵, though very little data so far to guide us in regards to other breeds.

Testicular Cancer

Since the testicles are removed with neutering, castration removes any risk of testicular cancer (assuming the castration is done before cancer develops). This needs to be compared to the risk of testicular cancer in intact dogs.

Testicular tumors are not uncommon in older intact dogs, with a reported incidence of 7%⁸. However, the prognosis for treating testicular tumors is very good owing to a low rate of metastasis⁹, so testicular cancer is an uncommon cause of death in intact dogs. For example, in a Purdue University breed health survey of Golden Retrievers¹⁰, deaths due to testicular cancer were sufficiently infrequent that they did not appear on list of significant causes of "Years of Potential Life Lost for Veterinary Confirmed Cause of Death" even though 40% of GR males were intact. Furthermore, the GRs who were treated for testicular tumors had a 90.9% cure rate. This agrees well with other work that found 6-14% rates of metastasis for testicular tumors in dogs¹¹.

The high cure rate of testicular tumors combined with their frequency suggests that fewer than 1% of intact male dogs will die of testicular cancer.

In summary, though it may be the most common reason why many advocate neutering young male dogs, the risk from life threatening testicular cancer is sufficiently low that neutering most male dogs to prevent it is difficult to justify.

An exception might be bilateral or unilateral cryptorchids, as testicles that are retained in the abdomen are 13.6 times more likely to develop tumors than descended testicles ¹² and it is also more difficult to detect tumors in undescended testicles by routine physical examination.

Osteosarcoma (Bone Cancer)

A multi-breed case-control study of the risk factors for osteosarcoma found that spay/neutered dogs (males or females) had twice the risk of developing osteosarcoma as did intact dogs¹³.

This risk was further studied in Rottwellers, a breed with a relatively high risk of osteosarcoma. This retrospective cohort study broke the risk down by age at spay/neuter, and found that the elevated risk of osteosarcoma is associated with spay/neuter of young dogs¹⁴. Rottwellers spayed/neutered before one year of age were 3.8 (males) or 3.1 (females) times more likely to develop osteosarcoma than intact dogs. Indeed, the combination of breed risk and early spay/neuter meant that Rottwellers spayed/neutered before one year of age had a 28.4% (males) and 25.1% (females) risk of developing osteosarcoma. These results are consistent with the earlier multi-breed study¹³ but have an advantage of assessing risk as a function of age at neuter. A logical conclusion derived from combining the findings of these two studies is that spay/neuter of dogs before 1 year of age is associated with a significantly increased risk of osteosarcoma.

The researchers suggest a cause-and-effect relationship, as sex hormones are known to influence the maintenance of skeletal structure and mass, and also because their findings showed an inverse relationship between time of exposure to sex hormones and risk of osteosarcoma.¹⁴

The risk of osteosarcoma increases with increasing breed size and especially height¹³. It is a common cause of death in medium/large, large, and giant breeds. Osteosarcoma is the third most common cause of death in Golden Retrievers¹⁰ and is even more common in larger breeds¹³.

Given the poor prognosis of osteosarcoma and its frequency in many breeds, spay/neuter of immature dogs in the medium/large, large, and giant breeds is apparently associated with a significant and elevated risk of death due to osteosarcoma.

Mammary Cancer (Breast Cancer)

Mammary tumors are by far the most common tumors in intact female dogs, constituting some 53% of all malignant tumors in female dogs in a study of dogs in Norway¹⁵ where spaying is much less common than in the USA.

50-60% of mammary tumors are malignant, for which there is a significant risk of metastasis¹⁶. Mammary tumors in dogs have been found to have estrogen receptors¹⁷, and the published research¹⁸ shows that the relative risk (odds ratio) that a female will develop mammary cancer compared to the risk in intact females is dependent on how many estrus cycles she experiences:

| # of estrus cycles before spay | Odds Ratio |
|--------------------------------|------------|
| None | 0.005 |
| 1 | 80.0 |
| 2 or more | 0.26 |
| Intact | 1.00 |
| | |

The same data when categorized differently showed that the relative risk (odds ratio) that females will develop mammary cancer compared to the risk in intact females indicated that;

| Age at Spaying | Odds Ratio |
|----------------|--|
| ≤ 29 months | 0.06 |
| ≥ 30 months | 0.40 (not statistically significant at the P<0.05 level) |
| Intact | 1.00 |

Please note that these are RELATIVE risks. This study has been referenced elsewhere many times but the results have often been misrepresented as absolute risks.

A similar reduction in breast cancer risk was found for women under the age of 40 who lost their estrogen production due to "artificial menopause" and breast cancer in humans is known to be estrogen activated.

Mammary cancer was found to be the 10th most common cause of years of lost life in Golden Retrievers, even though 86% of female GRs were spayed, at a median age of 3.4 yrs¹⁰. Considering that the female subset accounts for almost all mammary cancer cases, it probably would rank at about the 5th most common cause of years of lost life in female GRs. It would rank higher still if more female GRs had been kept intact up to 30 months of age.

Boxers, cocker spaniels, English Springer spaniels, and dachshunds are breeds at high risk of mammary tumors¹⁵. A population of mostly intact female Boxers was found to have a 40% chance of developing mammary cancer between the ages of 6-12 years of age¹⁵. There are some indications that purebred dogs may be at higher risk than mixed breed dogs, and purebred dogs with high inbreeding coefficients may be at higher risk than those with low inbreeding coefficients²⁰. More investigation is required to determine if these are significant.

In summary, spaying female dogs significantly reduces the risk of mammary cancer (a common cancer), and the fewer estrus cycles experienced at least up to 30 months of age, the lower the risk will be.

Female Reproductive Tract Cancer (Uterine, Cervical, and Ovarian Cancers)

Uterine/cervical tumors are rare in dogs, constituting just 0.3% of tumors in dogs²¹.

Spaying will remove the risk of ovarian tumors, but the risk is only 0.5%²².

While spaying will remove the risk of reproductive tract tumors, it is unlikely that surgery can be justified to prevent the risks of uterine, cervical, and ovarian cancers as the risks are so low.

Urinary Tract Cancer (Bladder and Urethra Cancers)

An age-matched retrospective study found that spay/neuter dogs were two times more likely to develop lower urinary tract tumors (bladder or urethra) compared to intact dogs²³. These tumors are nearly always malignant, but are infrequent, accounting for less than 1% of canine tumors. So this risk is unlikely to weigh heavily on spay/neuter decisions.

Airedales, Beagles, and Scottish Terriers are at elevated risk for urinary tract cancer while German Shepherds have a lower than average risk²³.

Hemangiosarcoma

Hemangiosarcoma is a common cancer in dogs. It is a major cause of death in some breeds, such as Salukis, French Bulldogs, Irish Water Spaniels, Flat Coated Retrievers, Golden Retrievers, Boxers, Afghan Hounds, English Setters, Scottish Terriesr, Boston Terriers, Bulldogs, and German Shepherd Dogs²⁴.

In an aged-matched case controlled study, spayed females were found to have a 2.2 times higher risk of splenic hemangiosarcoma compared to intact females²⁴.

A retrospective study of cardiac hemangiosarcoma risk factors found a >5 times greater risk in spayed female dogs compared to intact female dogs and a 1.6 times higher risk in neutered male dogs compared to intact male dogs. The authors suggest a protective effect of sex hormones against hemangiosarcoma, especially in females.

In breeds where hermangiosarcoma is an important cause of death, the increased risk associated with spay/neuter is likely one that should factor into decisions on whether or when to sterilize a dog.

Hypothyroidism

Spay/neuter in dogs was found to be correlated with a three fold increased risk of hypothyroidism compared to intact dogs. ²⁶.

The researchers suggest a cause-and-effect relationship: They wrote: "More important [than the mild direct impact on thyroid function] in the association between [spaying and] neutering and hypothyroidism may be the effect of sex hormones on the immune system. Castration increases the severity of autoimmune thyroiditis in mice" which may explain the link between spay/neuter and hypothyroidism in dogs.

Hypothyroidism in dogs causes obesity, lethargy, hair loss, and reproductive abnormalities.²⁷

The lifetime risk of hypothyroidism in breed health surveys was found to be 1 in 4 in Golden Retrievers¹⁰, 1 in 3 in Akitas²⁸, and 1 in 13 in Great Danes²⁹.

Obesity

Owing to changes in metabolism, spay/neuter dogs are more likely to be overweight or obese than intact dogs. One study found a two fold increased risk of obesity in spayed females compared to intact females³⁰. Another study found that spay/neuter dogs were 1.6 (females) or 3.0 (males) times more likely to be obese than intact dogs, and 1.2 (females) or 1.5 (males) times more likely to be overweight than intact dogs³¹.

A survey study of veterinary practices in the UK found that 21% of dogs were obese. 30

Being obese and/or overweight is associated with a host of health problems in dogs. Overweight dogs are more likely to be diagnosed with hyperadrenocorticism, ruptured cruciate ligament, hypothyroidism, lower urinary tract disease, and oral disease³². Obese dogs are more likely to be diagnosed with hypothyroidism, diabetes mellitus, pancreatitis, ruptured cruciate ligament, and neoplasia (tumors)³².

Diabetes

Some data indicate that neutering doubles the risk of diabetes in male dogs, but other data showed no significant change in diabetes risk with neutering³³. In the same studies, no association was found between spaying and the risk of diabetes.

Adverse Vaccine Reactions

A retrospective cohort study of adverse vaccine reactions in dogs was conducted, which included allergic reactions, hives, anaphylaxis, cardiac arrest, cardiovascular shock, and sudden death. Adverse reactions were 30% more likely in spayed females than intact females, and 27% more likely in neutered males than intact males³⁴.

The investigators discuss possible cause-and-effect mechanisms for this finding, including the roles that sex hormones play in body's ability to mount an immune response to vaccination.³⁴

Toy breeds and smaller breeds are at elevated risk of adverse vaccine reactions, as are Boxers, English Bulldogs, Lhasa Apsos, Weimaraners, American Eskimo Dogs, Golden Retrievers, Basset Hounds, Welsh Corgis, Siberian Huskies, Great Danes, Labrador Retrievers, Doberman Pinschers, American Pit Bull Terriers, and Akitas. Mixed breed dogs were found to be at lower risk, and the authors suggest genetic hetereogeneity (hybrid vigor) as the cause.

Urogenital Disorders

Urinary incontinence is common in spayed female dogs, which can occur soon after spay surgery or after a delay of up to several years. The incidence rate in various studies is 4-20% ³⁵, ³⁶, ³⁷ for spayed females compared to only 0.3% in intact females³⁸. Urinary incontinence is so strongly linked to spaying that it is commonly called "spay incontinence" and is caused by urethral sphincter incompetence³⁹, though the biological mechanism is unknown. Most (but not all) cases of urinary incontinence respond to medical treatment, and in many cases this treatment needs to be continued for the duration of the dog's life.⁴⁰

A retrospective study found that persistent or recurring urinary tract (bladder) infections (UTIs) were 3-4 times more likely in spayed females dogs than in intact females 41 . Another retrospective study found that female dogs spayed before 5 $\frac{1}{2}$ months of age were 2.76 times more likely to develop UTIs compared to those spayed after 5 $\frac{1}{2}$ months of age.

Depending on the age of surgery, spaying causes abnormal development of the external genitalia. Spayed temales were found to have an increased risk of recessed vulva, vaginal dermatitis, vaginitis, and UTIs. ⁴³ The risk is higher still for female dogs spayed before puberty. ⁴³

Pyometra (Infection of the Uterus)

Pet insurance data in Sweden (where spaying is very uncommon) found that 23% of all female dogs developed pyometra before 10 years of age⁴⁴. Bernese Mountain dogs, Rottweilers, rough-haired Collies, Cavalier King Charles Spaniels and Golden Retrievers were found to be high risk breeds⁴⁴. Female dogs that have not whelped pupples are at elevated risk for pyometra⁴⁵. Rarely, spayed female dogs can develop "stump pyometra" related to incomplete removal of the uterus.

Pyometra can usually be treated surgically or medically, but 4% of pyometra cases led to death⁴⁴. Combined with the incidence of pyometra, this suggests that about 1% of intact female dogs will die from pyometra.

Perianal Fistulas

Male dogs are twice as likely to develop perianal fistulas as females, and spay/neutered dogs have a decreased risk compared to intact dogs⁴⁶.

German Shepherd Dogs and Irish Setters are more likely to develop perianal fistulas than are other breeds. 46

Non-cancerous Disorders of the Prostate Gland

The incidence of benign prostatic hypertrophy (BPH, enlarged prostate) increases with age in intact male dogs, and occurs in more than 80% of intact male dogs older than the age of 5 years⁴⁷. Most cases of BPH cause no problems, but in some cases the dog will have difficulty defecating or urinating.

Neutering will prevent BPH. If neutering is done after the prostate has become enlarged, the enlarged prostate will shrink relatively quickly.

BPH is linked to other problems of the prostate gland, including infections, abscesses, and cysts, which can sometimes have serious consequences.

Orthopedic Disorders

In a study of beagles, surgical removal of the ovaries (as happens in spaying) caused an increase in the rate of remodeling of the ilium (pelvic bone)⁴⁸, suggesting an increased risk of hip dysplasia with spaying. Spaying was also found to cause a net loss of bone mass in the spine⁴⁹.

Spay/neuter of immature dogs delays the closure of the growth plates in bones that are still growing, causing those bones to end up significantly longer than in intact dogs or those spay/neutered after maturity⁵⁰. Since the growth plates in various bones close at different times, spay/neuter that is done after some growth plates have closed but before other growth plates have closed might result in a dog with unnatural proportions, possibly impacting performance and long term durability of the joints.

Spay/neuter is associated with a two fold increased risk of cranial cruciate ligament rupture⁵¹. Perhaps this is associated with the increased risk of obesity³⁰.

Spay/neuter before 5 ½ months of age is associated with a 70% increased aged-adjusted risk of hip dysplasia compared to dogs spayed/neutered after 5 ½ months of age, though there were some indications that the former may have had a lower severity manifestation of the disease 42. The researchers suggest "it is possible that the increase in bone length that results from early-age gonadectomy results in changes in joint conformation, which could lead to a diagnosis of hip dysplasia."

In a breed health survey study of Airedales, spay/neuter dogs were significantly more likely to suffer hip dysplasia as well as "any musculoskeletal disorder", compared to intact dogs⁵², however possible confounding factors were not controlled for, such as the possibility that some dogs might have been spayed/neutered because they had hip dysplasia or other musculoskeletal disorders.

Compared to intact dogs, another study found that dogs neutered six months prior to a diagnosis of hip dysplasia were 1.5 times as likely to develop clinical hip dysplasia. 59

Compared to intact dogs, spayed/neutered dogs were found to have a 3.1 fold higher risk of patellar luxation.⁵⁴

Geriatric Cognitive Impairment

Neutered male dogs and spayed female dogs are at increased risk of progressing from mild to severe geriatric cognitive impairment compared to intact male dogs⁵⁵. There weren't enough intact geriatric females available for the study to determine their risk.

Geriatric cognitive impairment includes disorientation in the house or outdoors, changes in social interactions with human family members, loss of house training, and changes in the sleep-wake cycle⁵⁵.

The investigators state "This finding is in line with current research on the neuro-protective roles of testosterone and estrogen at the cellular level and the role of estrogen in preventing Alzheimer's disease in human females. One would predict that estrogens would have a similar protective role in the sexually intact female dogs; unfortunately too few sexually intact female dogs were available for inclusion in the present study to test the hypothesis" state of the sexual state o

CONCLUSIONS

An objective reading of the veterinary medical literature reveals a complex situation with respect to the long-term health risks and benefits associated with spay/neuter in dogs. The evidence shows that spay/neuter correlates with both positive AND adverse health effects in dogs. It also suggests how much we really do not yet understand about this subject.

On balance, it appears that no compelling case can be made for neutering most male dogs to prevent future health problems, especially immature male dogs. The number of health problems associated with neutering may exceed the associated health benefits in most cases.

For female dogs, the situation is more complex. The number of health benefits associated with spaying may exceed the associated health problems in many (not all) cases. On balance, whether spaying improves the odds of overall good health or degrades them probably depends on the age of the dog and the relative risk of various diseases in the different breeds.

The traditional spay/neuter age of six months as well as the modern practice of pediatric spay/neuter appear to predispose dogs to health risks that could otherwise be avoided by waiting until the dog is physically mature, or perhaps in the case of many male dogs, foregoing it altogether unless medically necessary.

The balance of long-term health risks and benefits of spay/neuter will vary from one dog to the next. Breed, age, and gender are variables that must be taken into consideration in conjunction with non-medical factors for each individual dog. Across-the-board recommendations for all dogs do not appear to be supportable from findings in the veterinary medical literature.

REFERENCES

- ¹ Burrow R, Batchelor D, Cripps P. Complications observed during and after ovariohysterectomy of 142 bitches at a veterinary teaching hospital. Vet Rec. 2005 Dec 24-31;157(26);829-33.
- ² Pollari FL, Bonnett BN, Bamsey, SC, Meek, AH, Allen, DG (1996) Postoperative complications of elective surgeries in dogs and cats determined by examining electronic and medical records. Journal of the American Veterinary Medical Association 208, 1882-1886
- ³ Dorn AS, Swist RA. (1977) Complications of canine ovariohysterectomy. Journal of the American Animal Hospital Association 13, 720-724
- ⁴ Pollari FL, Bonnett BN. Evaluation of postoperative complications following elective surgeries of dogs and cats at private practices using computer records, Can Vet J. 1996 November; 37(11): 672–678.
- ⁵ Teske E, Naan EC, van Dijk EM, van Garderen E, Schalken JA. Canine prostate carcinoma: epidemiological evidence of an increased risk in castrated dogs. Mol Cell Endocrinol. 2002 Nov 29;197(1-2):251-5.
- ⁶ Sorenmo KU, Goldschmidt M, Shofer F, Ferrocone J. Immunohistochemical characterization of canine prostatic carcinoma and correlation with castration status and castration time. Vet Comparative Oncology. 2003 Mar; 1 (1): 48
- ⁷ Weaver, AD. Fifteen cases of prostatic carcinoma in the dog. Vet Rec. 1981; 109, 71-75.
- ⁸ Cohen D, Reif JS, Brodey RS, et al: Epidemiological analysis of the most prevalent sites and types of canine neoplasia observed in a veterinary hospital. Cancer Res 34:2859-2868, 1974
- Theilen GH, Madewell BR. Tumors of the genital system. Part II. In:Theilen GH, Madewell BR, eds. Veterinary cancer medicine. 2nd ed.Lea and Febinger, 1987:583–600.
- ¹⁰ Glickman LT, Glickman N, Thorpe R. The Golden Retriever Club of America National Health Survey 1998-1999 http://www.vet.purdue.edu//epi/golden_retriever_final22.pdf
- ¹¹ Handbook of Small Animal Practice, 3rd ed
- ¹² Hayes HM Jr, Pendergrass TW. Canine testicular tumors: epidemiologic features of 410 dogs. Int J Cancer 1976 Oct 15;18(4):482-7
- ¹³ Ru G, Terracini B, Glickman LT. (1998) Host-related risk factors for canine osteosarcoma. Vet J 1998 Jul;156(1):31-9
- ¹⁴ Cooley DM, Beranek BC, Schlittler DL, Glickman NW, Glickman LT, Waters DJ. Endogenous gonadal hormone exposure and bone sarcoma risk. Cancer Epidemiol Biomarkers Prev. 2002 Nov;11(11):1434-40.
- ¹⁵ Moe L. Population-based incidence of mammary tumours in some dog breeds. J of Reproduction and Fertility Supplment 57, 439-443.
- ¹⁶ Ferguson HR; Vet Clinics of N Amer: Small Animal Practice; Vol 15, No 3, May 1985
- ¹⁷ MacEwen EG, Patnaik AK, Harvey HJ Estrogen receptors in canine mammary tumors. Cancer Res., 42: 2255-2259, 1982.
- ¹⁸ Schneider, R, Dorn, CR, Taylor, DON. Factors Influencing Canine Mammary Cancer Development and Postsurgical Survival. J Natl Cancer Institute, Vol 43, No 6, Dec. 1969
- ¹⁹ Feinleib M: Breast cancer and artificial menopause: A cohort study. J Nat Cancer Inst 41: 315-329, 1968.
- ²⁰ Dorn CR and Schneider R. Inbreeding and canine mammary cancer. A retrospective study. J Natl Cancer Inst. 57: 545-548, 1976.
- ²¹ Brodey RS: Canine and feline neoplasia. Adv Vet Sci Comp Med 14:309-354, 1970
- ²² Hayes A, Harvey H J: Treatment of metastatic granulosa cell tumor in a dog. J Am Vet Med Assoc 174:1304-1306, 1979

²³ Norris AM, Laing EJ, Valli VE, Withrow SJ. J Vet Intern Med 1992 May; 6(3):145-53

²⁴ Prymak C, McKee LJ, Goldschmidt MH, Glickman LT. Epidemiologic, clinical, pathologic, and prognostic characteristics of splenic hemangiosarcoma and splenic hematoma in dogs: 217 cases (1985). J Am Vet Med Assoc 1988 Sep; 193(6):706-12

²⁵ Ware WA, Hopper, DL. Cardiac Tumors in Dogs: 1982-1995. J Vet Intern Med 1999;13:95–103.

 $^{^{26}}$ Panciera DL. Hypothyroidism in dogs: 66 cases (1987-1992). J Am Vet Med Assoc. 1994 Mar 1;204(5):761-7

²⁷ Panciera DL. Canine hypothyroidism. Part I. Clinical findings and control of thyroid hormone secretion and metabolism. Compend Contin Pract Vet 1990: 12: 689-701.

²⁸ Glickman LT, Glickman N, Raghaven M, The Akita Club of America National Health Survey 2000-2001. http://www.vet.purdue.edu/epi/akita_final_2.pdf

²⁹ Glickman LT, HogenEsch H, Raghavan M, Edinboro C, Scott-Moncrieff C. Final Report to the Hayward Foundation and The Great Dane Health Foundation of a Study Titled Vaccinosis in Great Danes. 1 Jan 2004. http://www.vet.purdue.edu/epi/great_dane_vaccinosis_fullreport_jan04.pdf

 $^{^{30}}$ Edney AT, Smith PM. Study of obesity in dogs visiting veterinary practices in the United Kingdom. .Vet Rec. 1986 Apr 5;118(14):391-6.

³¹ McGreevy PD, Thomson PC, Pride C, Fawcett A, Grassi T, Jones B. Prevalence of obesity in dogs examined by Australian veterinary practices and the risk factors involved. Vet Rec. 2005 May 28;156(22):695-702.

³² Lund EM, Armstrong PJ, Kirk, CA, Klausner, JS. Prevalence and Risk Factors for Obesity in Adult Dogs from Private US Veterinary Practices. Intern J Appl Res Vet Med • Vol. 4, No. 2, 2006.

⁹³ Marmor M, Willeberg P, Glickman LT, Priester WA, Cypess RH, Hurvitz AI. Epizootiologic patterns of diabetes mellitus in dogs Am J Vet Res. 1982 Mar;43(3):465-70. ..

³⁴ Moore GE, Guptill LF, Ward MP, Glickman NW, Faunt KF, Lewis HB, Glickman LT. Adverse events diagnosed within three days of vaccine administration in dogs. JAVMA Vol 227, No 7, Oct 1, 2005

³⁵ Thrusfield MV, Holt PE, Muirhead RH. Acquired urinary incontinence in bitches: its incidence and relationship to neutering practices.. J Small Anim Pract. 1998. Dec;39(12):559-66.

³⁶ Stocklin-Gautschi NM, Hassig M, Reichler IM, Hubler M, Arnold S. The relationship of urinary incontinence to early spaying in bitches. J Reprod Fertil Suppl. 2001;57:233-6...

³⁷ Arnold S, Arnold P, Hubler M, Casal M, and Rüsch P. Urinary Incontinence in spayed bitches: prevalence and breed disposition. European Journal of Campanion Animal Practice. 131, 259-263.

³⁸ Thrusfield MV 1985 Association between urinary incontinence and spaying in bitches Vet Rec 116 695

³⁹ Richter KP, Ling V. Clinical response and urethral pressure profile changes after phenypropanolamine in dogs with primary sphincter incompetence. J Am Vet Med Assoc 1985: 187: 605-611.

⁴⁰ Holt PE. Urinary incontinence in dogs and cats. Vet Rec 1990: 127: 347-350.

⁴¹ Seguin MA, Vaden SL, Altier C, Stone E, Levine JF (2003) Persistent Urinary Tract Infections and Reinfections in 100 Dogs (1989–1999). Journal of Veterinary Internal Medicine: Vol. 17, No. 5 pp. 622–631.

 $^{^{\}rm 42}$ Spain CV, Scarlett JM, Houpt KA. Long-term risks and benefits of early-age gonadectomy in dogs. JAVMA 2004;224:380-387.

⁴³ Verstegen-Onclin K, Verstegen J. Non-reproductive Effects of Spaying and Neutering: Effects on the Urogenital System. Proceedings of the Third International Symposium on Non-Surgical Contraceptive Methods for Pet Population Control http://www.acc-d.org/2006%20Symposium%20Docs/Session%20Lpdf

⁴⁴ Hagman R: New aspects of canine pyometra. Doctoral thesis, Swedish University of Agricultural Sciences, Uppsala, 2004.

⁴⁵ Chastain CB, Panciera D, Waters C: Associations between age, parity, hormonal therapy and breed, and pyometra in Finnish dogs. Small Anim Endocrinol 1999; 9: 8.

 $^{^{\}rm 46}$ Killingsworth CR, Walshaw R, Dunstan RW, Rosser, EJ. Bacterial population and histologic changes in dogs with perianal fistula. Am J Vet Res, Vol 49, No. 10, Oct 1988.

⁴⁷ Johnston SD, Kamolpatana K, Root-Kustritz MV, Johnston GR, Prostatic disorders in the dog. Anim Reprod. Sci Jul 2;60-61;405-415. .

⁴⁸ Dannuccia GA, Martin RB., Patterson-Buckendahl P Ovariectomy and trabecular bone remodeling in the dog. Calcif Tissue Int 1986; 40: 194-199.

⁴⁹ Martin RB, Butcher RL, Sherwood L,L Buckendahl P, Boyd RD, Farris D, Sharkey N, Dannucci G. Effects of ovariectomy in beagle dogs. Bone 1987; 8:23-31

⁵⁰ Salmeri KR, Bloomberg MS, Scruggs SL, Shille V. Gonadectomy in immature dogs: Effects on skeletal, physical, and behavioral development, JAVMA, Vol 198, No. 7, April 1991.

⁵¹ Whitehair JG, Vasseur PB, Willits NH. Epidemiology of cranial cruciate ligament rupture in dogs. J Am Vet Med Assoc. 1993 Oct 1;203(7):1016-9.

⁵² Glickman LT, Airedale Terrier Club of America, Airedale Terrier Health Survey 2000-2001 http://www.vet.purdue.edu//epi/Airedale%20final%20report_revised.pdf

⁵³ van Hagen MA, Ducro BJ, van den Broek J, Knol BW. Incidence, risk factors, and heritability estimates of hind limb lameness caused by hip dysplasia in a birth cohort of boxers. Am J Vet Res. 2005 Feb;66(2):307-12.

⁵⁴ B. Vidoni, I. Sommerfeld-Stur und E. Eisenmenger: Diagnostic and genetic aspects of patellar luxation in small and miniature breed dogs in Austria. Wien.Tierarztl.Mschr. (2005) 92, p170 – 181

⁵⁵ Hart BL. Effect of gonadectomy on subsequent development of age-related cognitive impairment in dogs. J Am Vet Med Assoc. 2001 Jul 1;219(1):51-6.

| To: | Brian Walters | From: | Cathie Turner | |
|------|--|--------|---------------|--|
| Fax: | 12139781079 | Pages: | 13 | |
| Re: | Oppose File Item # 07-1212 Spay/Neuter Ordinance) | Date: | 1/31/2008 | |

X Urgent For Review Please Comment Please Reply For Information

• Comments:

Honorable City Council Member:

I respectfully urge you to vote no on File Item # 07-1212 (Spay/Neuter Ordinance). Spay/neuter has adverse health risks that must be weighed against its benefits, on a case by case basis. One size does not fit all. Please see the attached report. Thank you.

Cathie Turner Concerned Dog Owners of California

Long-Term Health Risks and Benefits Associated with Spay / Neuter in Dogs Laura J. Sanborn, M.S. May 14, 2007

Precis

At some point, most of us with an interest in dogs will have to consider whether or not to spay / neuter our pet. Tradition holds that the benefits of doing so at an early age outweigh the risks. Often, tradition holds sway in the decision-making process even after countervailing evidence has accumulated.

Ms Sanborn has reviewed the veterinary medical literature in an exhaustive and scholarly treatise, attempting to unravel the complexities of the subject. More than 50 peer-reviewed papers were examined to assess the health impacts of spay / neuter in female and male dogs, respectively. One cannot ignore the findings of increased risk from osteosarcoma, hemangiosarcoma, hypothyroidism, and other less frequently occurring diseases associated with neutering male dogs. It would be irresponsible of the veterinary profession and the pet owning community to fail to weigh the relative costs and benefits of neutering on the animal's health and well-being. The decision for females may be more complex, further emphasizing the need for individualized veterinary medical decisions, not standard operating procedures for all patients.

No sweeping generalizations are implied in this review. Rather, the author asks us to consider all the health and disease information available as individual animals are evaluated. Then, the best decisions should be made accounting for gender, age, breed, and even the specific conditions under which the long-term care, housing and training of the animal will occur.

This important review will help veterinary medical care providers as well as pet owners make informed decisions. Who could ask for more?

Larry S. Katz, PhD Associate Professor and Chair Animal Sciences Rutgers University New Brunswick, NJ 08901

INTRODUCTION

Dog owners in America are frequently advised to spay/neuter their dogs for health reasons. A number of health benefits are cited, yet evidence is usually not cited to support the alleged health benefits.

When discussing the health impacts of spay/neuter, health risks are often not mentioned. At times, some risks are mentioned, but the most severe risks usually are not.

This article is an attempt to summarize the long-term health risks and benefits associated with spay/neuter in dogs that can be found in the veterinary medical literature. This article will not discuss the impact of spay/neuter on population control, or the impact of spay/neuter on behavior.

Nearly all of the health risks and benefits summarized in this article are findings from retrospective epidemiological research studies of dogs, which examine potential associations by looking backwards in time. A few are from prospective research studies, which examine potential associations by looking forward in time.

SUMMARY

An objective reading of the veterinary medical literature reveals a complex situation with respect to the long-term health risks and benefits associated with spay/neuter in dogs. The evidence shows that spay/neuter

correlates with both positive AND adverse health effects in dogs. It also suggests how much we really do not yet understand about this subject.

On balance, it appears that no compelling case can be made for neutering most male dogs, especially immature male dogs, in order to prevent future health problems. The number of health problems associated with neutering may exceed the associated health benefits in most cases.

On the positive side, neutering male dogs

- eliminates the small risk (probably <1%) of dying from testicular cancer
- reduces the risk of non-cancerous prostate disorders
- reduces the risk of perianal fistulas
- may possibly reduce the risk of diabetes (data inconclusive)

On the negative side, neutering male dogs

- if done before 1 year of age, significantly increases the risk of osteosarcoma (bone cancer); this is a common cancer in medium/large and larger breeds with a poor prognosis.
- increases the risk of cardiac hemangiosarcoma by a factor of 1.6
- triples the risk of hypothyroidism
- increases the risk of progressive geriatric cognitive impairment
- · triples the risk of obesity, a common health problem in dogs with many associated health problems
- quadruples the small risk (<0.6%) of prostate cancer
- doubles the small risk (<1%) of urinary tract cancers
- increases the risk of orthopedic disorders
- increases the risk of adverse reactions to vaccinations

For female dogs, the situation is more complex. The number of health benefits associated with spaying may exceed the associated health problems in some (not all) cases. On balance, whether spaying improves the odds of overall good health or degrades them probably depends on the age of the female dog and the relative risk of various diseases in the different breeds.

On the positive side, spaying female dogs

- if done before 2.5 years of age, greatly reduces the risk of mammary tumors, the most common malignant tumors in female dogs
- nearly eliminates the risk of pyometra, which otherwise would affect about 23% of intact female dogs; pyometra kills about 1% of intact female dogs
- reduces the risk of perianal fistulas
- removes the very small risk (≤0.5%) from uterine, cervical, and ovarian tumors

On the negative side, spaying female dogs

- If done before 1 year of age, significantly increases the risk of osteosarcoma (bone cancer); this is a common cancer in larger breeds with a poor prognosis
- increases the risk of splenic hemangiosarcoma by a factor of 2.2 and cardiac hemangiosarcoma by a factor of >5; this is a common cancer and major cause of death in some breeds
- · triples the risk of hypothyroidism
- increases the risk of obesity by a factor of 1.6-2, a common health problem in dogs with many associated health problems
- causes urinary "spay incontinence" in 4-20% of female dogs
- increases the risk of persistent or recurring urinary tract infections by a factor of 3-4
- increases the risk of recessed vulva, vaginal dermatitis, and vaginitis, especially for female dogs spayed before puberty
- doubles the small risk (<1%) of urinary tract tumors
- increases the risk of orthopedic disorders
- · increases the risk of adverse reactions to vaccinations

One thing is clear – much of the spay/neuter information that is available to the public is unbalanced and contains claims that are exaggerated or unsupported by evidence. Rather than helping to educate pet

owners, much of it has contributed to common misunderstandings about the health risks and benefits associated of spay/neuter in dogs.

The traditional spay/neuter age of six months as well as the modern practice of pediatric spay/neuter appear to predispose dogs to health risks that could otherwise be avoided by waiting until the dog is physically mature, or perhaps in the case of many male dogs, foregoing it altogether unless medically necessary.

The balance of long-term health risks and benefits of spay/neuter will vary from one dog to the next. Breed, age, and gender are variables that must be taken into consideration in conjunction with non-medical factors for each individual dog. Across-the-board recommendations for all pet dogs do not appear to be supportable from findings in the veterinary medical literature.

FINDINGS FROM STUDIES

This section summarizes the diseases or conditions that have been studied with respect to spay/neuter in dogs.

Complications from Spay/Neuter Surgery

All surgery incurs some risk of complications, including adverse reactions to anesthesia, hemorrhage, inflammation, infection, etc. Complications include only immediate and near term impacts that are clearly linked to the surgery, not to longer term impacts that can only be assessed by research studies.

At one veterinary teaching hospital where complications were tracked, the rates of intraoperative, postoperative and total complications were 6.3%, 14.1% and 20.6%, respectively as a result of spaying female dogs¹. Other studies found a rate of total complications from spaying of 17.7%² and 23%³. A study of Canadian veterinary private practitioners found complication rates of 22% and 19% for spaying female dogs and neutering male dogs, respectively⁴.

Serious complications such as infections, abscesses, rupture of the surgical wound, and chewed out sutures were reported at a 1-4% frequency, with spay and castration surgeries accounting for 90% and 10% of these complications, respectively.

The death rate due to complications from spay/neuter is low, at around 0.1%2.

Prostate Cancer

Much of the spay/neuter information available to the public asserts that neutering will reduce or eliminate the risk that male dogs develop prostate cancer. This would not be an unreasonable assumption, given that prostate cancer in humans is linked to testosterone. But the evidence in dogs does not support this claim. In fact, the strongest evidence suggests just the opposite.

There have been several conflicting epidemiological studies over the years that found either an increased risk or a decreased risk of prostate cancer in neutered dogs. These studies did not utilize control populations, rendering these results at best difficult to interpret. This may partially explain the conflicting results.

More recently, two retrospective studies were conducted that did utilize control populations. One of these studies involved a dog population in Europe⁵ and the other involved a dog population in America⁶. Both studies found that neutered male dogs have a four times *higher* risk of prostate cancer than intact dogs.

Based on their results, the researchers suggest a cause-and-effect relationship: "this suggests that castration does not initiate the development of prostatic carcinoma in the dog, but does favor tumor progression" and also "Our study found that most canine prostate cancers are of ductal/urothelial origin....The relatively low incidence of prostate cancer in intact dogs may suggest that testicular hormones

are in fact protective against ductal/urothelial prostatic carcinoma, or may have indirect effects on cancer development by changing the environment in the prostate."

This needs to be put in perspective. Unlike the situation in humans, prostate cancer is uncommon in dogs. Given an incidence of prostate cancer in dogs of less than 0.6% from necropsy studies⁷, it is difficult to see that the risk of prostate cancer should factor heavily into most neutering decisions. There is evidence for an increased risk of prostate cancer in at least one breed (Bouviers)⁵, though very little data so far to guide us in regards to other breeds.

Testicular Cancer

Since the testicles are removed with neutering, castration removes any risk of testicular cancer (assuming the castration is done before cancer develops). This needs to be compared to the risk of testicular cancer in intact dogs.

Testicular tumors are not uncommon in older intact dogs, with a reported incidence of 7%⁸. However, the prognosis for treating testicular tumors is very good owing to a low rate of metastasis⁹, so testicular cancer is an uncommon cause of death in intact dogs. For example, in a Purdue University breed health survey of Golden Retrievers¹⁰, deaths due to testicular cancer were sufficiently infrequent that they did not appear on list of significant causes of "Years of Potential Life Lost for Veterinary Confirmed Cause of Death" even though 40% of GR males were intact. Furthermore, the GRs who were treated for testicular tumors had a 90.9% cure rate. This agrees well with other work that found 6-14% rates of metastasis for testicular tumors in dogs¹¹.

The high cure rate of testicular tumors combined with their frequency suggests that fewer than 1% of intact male dogs will die of testicular cancer.

In summary, though it may be the most common reason why many advocate neutering young male dogs, the risk from life threatening testicular cancer is sufficiently low that neutering most male dogs to prevent it is difficult to justify.

An exception might be bilateral or unilateral cryptorchids, as testicles that are retained in the abdomen are 13.6 times more likely to develop tumors than descended testicles ¹² and it is also more difficult to detect tumors in undescended testicles by routine physical examination.

Osteosarcoma (Bone Cancer)

A multi-breed case-control study of the risk factors for osteosarcoma found that spay/neutered dogs (males or females) had twice the risk of developing osteosarcoma as did intact dogs¹³.

This risk was further studied in Rottweilers, a breed with a relatively high risk of osteosarcoma. This retrospective cohort study broke the risk down by age at spay/neuter, and found that the elevated risk of osteosarcoma is associated with spay/neuter of young dogs¹⁴. Rottweilers spayed/neutered before one year of age were 3.8 (males) or 3.1 (females) times more likely to develop osteosarcoma than intact dogs. Indeed, the combination of breed risk and early spay/neuter meant that Rottweilers spayed/neutered before one year of age had a 28.4% (males) and 25.1% (females) risk of developing osteosarcoma. These results are consistent with the earlier multi-breed study¹³ but have an advantage of assessing risk as a function of age at neuter. A logical conclusion derived from combining the findings of these two studies is that spay/neuter of dogs before 1 year of age is associated with a significantly increased risk of osteosarcoma.

The researchers suggest a cause-and-effect relationship, as sex hormones are known to influence the maintenance of skeletal structure and mass, and also because their findings showed an inverse relationship between time of exposure to sex hormones and risk of osteosarcoma.¹⁴

The risk of osteosarcoma increases with increasing breed size and especially height¹³. It is a common cause of death in medium/large, large, and giant breeds. Osteosarcoma is the third most common cause of death in Golden Retrievers¹⁰ and is even more common in larger breeds¹³.

Given the poor prognosis of osteosarcoma and its frequency in many breeds, spay/neuter of immature dogs in the medium/large, large, and giant breeds is apparently associated with a significant and elevated risk of death due to osteosarcoma.

Mammary Cancer (Breast Cancer)

Mammary tumors are by far the most common tumors in intact temale dogs, constituting some 53% of all malignant tumors in female dogs in a study of dogs in Norway¹⁵ where spaying is much less common than in the USA.

50-60% of mammary tumors are malignant, for which there is a significant risk of metastasis¹⁶. Mammary tumors in dogs have been found to have estrogen receptors¹⁷, and the published research¹⁸ shows that the relative risk (odds ratio) that a female will develop mammary cancer compared to the risk in intact females is dependent on how many estrus cycles she experiences:

| # of estrus cycles before spay | Odds Ratio |
|--------------------------------|------------|
| None | 0.005 |
| 1 | 0.08 |
| 2 or more | 0.26 |
| Intact | 1.00 |

The same data when categorized differently showed that the relative risk (odds ratio) that females will develop mammary cancer compared to the risk in intact females indicated that:

| Age at Spaying | Odds Ratio |
|--------------------------------|---|
| ≤ 29 months ≥ 30 months Intact | 0.06 0.40 (not statistically significant at the P<0.05 level) |
| initaci | 1.00 |

Please note that these are RELATIVE risks. This study has been referenced elsewhere many times but the results have often been misrepresented as absolute risks.

A similar reduction in breast cancer risk was found for women under the age of 40 who lost their estrogen production due to "artificial menopause" and breast cancer in humans is known to be estrogen activated.

Mammary cancer was found to be the 10th most common cause of years of lost life in Golden Retrievers, even though 86% of female GRs were spayed, at a median age of 3.4 yrs¹⁰. Considering that the female subset accounts for almost all mammary cancer cases, it probably would rank at about the 5th most common cause of years of lost life in female GRs. It would rank higher still if more female GRs had been kept intact up to 30 months of age.

Boxers, cocker spaniels, English Springer spaniels, and dachshunds are breeds at high risk of mammary tumors ¹⁵. A population of mostly intact female Boxers was found to have a 40% chance of developing mammary cancer between the ages of 6-12 years of age ¹⁵. There are some indications that purebred dogs may be at higher risk than mixed breed dogs, and purebred dogs with high inbreeding coefficients may be at higher risk than those with low inbreeding coefficients²⁰. More investigation is required to determine if these are significant.

In summary, spaying female dogs significantly reduces the risk of mammary cancer (a common cancer), and the fewer estrus cycles experienced at least up to 30 months of age, the lower the risk will be.

Female Reproductive Tract Cancer (Uterine, Cervical, and Ovarian Cancers)

Uterine/cervical tumors are rare in dogs, constituting just 0.3% of tumors in dogs²¹.

Spaying will remove the risk of ovarian tumors, but the risk is only 0.5%22.

While spaying will remove the risk of reproductive tract tumors, it is unlikely that surgery can be justified to prevent the risks of uterine, cervical, and ovarian cancers as the risks are so low.

Urinary Tract Cancer (Bladder and Urethra Cancers)

An age-matched retrospective study found that spay/neuter dogs were two times more likely to develop lower urinary tract tumors (bladder or urethra) compared to intact dogs²³. These tumors are nearly always malignant, but are infrequent, accounting for less than 1% of canine tumors. So this risk is unlikely to weigh heavily on spay/neuter decisions.

Airedales, Beagles, and Scottish Terriers are at elevated risk for urinary tract cancer while German Shepherds have a lower than average ${\rm risk}^{23}$.

Hemangiosarcoma

Hemangiosarcoma is a common cancer in dogs. It is a major cause of death in some breeds, such as Salukis, French Bulldogs, Irish Water Spaniels, Flat Coated Retrievers, Golden Retrievers, Boxers, Afghan Hounds, English Setters, Scottish Terriesr, Boston Terriers, Bulldogs, and German Shepherd Dogs²⁴.

In an aged-matched case controlled study, spayed females were found to have a 2.2 times higher risk of splenic hemangiosarcoma compared to intact females 24 .

A retrospective study of cardiac hemangiosarcoma risk factors found a >5 times greater risk in spayed female dogs compared to intact female dogs and a 1.6 times higher risk in neutered male dogs compared to intact male dogs. The authors suggest a protective effect of sex hormones against hemangiosarcoma, especially in females.

In breeds where hermangiosarcoma is an important cause of death, the increased risk associated with spay/neuter is likely one that should factor into decisions on whether or when to sterilize a dog.

Hypothyroidism

Spay/neuter in dogs was found to be correlated with a three fold increased risk of hypothyroidism compared to intact dogs. 26 .

The researchers suggest a cause-and-effect relationship: They wrote: "More important [than the mild direct impact on thyroid function] in the association between [spaying and] neutering and hypothyroidism may be the effect of sex hormones on the immune system. Castration increases the severity of autoimmune thyroiditis in mice" which may explain the link between spay/neuter and hypothyroidism in dogs.

Hypothyroidism in dogs causes obesity, lethargy, hair loss, and reproductive abnormalities.²⁷

The lifetime risk of hypothyroidism in breed health surveys was found to be 1 in 4 in Golden Retrievers 10 , 1 in 3 in Akitas 28 , and 1 in 13 in Great Danes 29 .

Obesity

Owing to changes in metabolism, spay/neuter dogs are more likely to be overweight or obese than intact dogs. One study found a two fold increased risk of obesity in spayed females compared to intact females³⁰. Another study found that spay/neuter dogs were 1.6 (females) or 3.0 (males) times more likely to be obese than intact dogs, and 1.2 (females) or 1.5 (males) times more likely to be overweight than intact dogs³¹.

A survey study of veterinary practices in the UK found that 21% of dogs were obese. 30

Being obese and/or overweight is associated with a host of health problems in dogs. Overweight dogs are more likely to be diagnosed with hyperadrenocorticism, ruptured cruciate ligament, hypothyroidism, lower urinary tract disease, and oral disease³². Obese dogs are more likely to be diagnosed with hypothyroidism, diabetes mellitus, pancreatitis, ruptured cruciate ligament, and neoplasia (tumors)³².

Diabetes

Some data indicate that neutering doubles the risk of diabetes in male dogs, but other data showed no significant change in diabetes risk with neutering³³. In the same studies, no association was found between spaying and the risk of diabetes.

Adverse Vaccine Reactions

A retrospective cohort study of adverse vaccine reactions in dogs was conducted, which included allergic reactions, hives, anaphylaxis, cardiac arrest, cardiovascular shock, and sudden death. Adverse reactions were 30% more likely in spayed females than intact females, and 27% more likely in neutered males than intact males³⁴.

The investigators discuss possible cause-and-effect mechanisms for this finding, including the roles that sex hormones play in body's ability to mount an immune response to vaccination.³⁴

Toy breeds and smaller breeds are at elevated risk of adverse vaccine reactions, as are Boxers, English Bulldogs, Lhasa Apsos, Weimaraners, American Eskimo Dogs, Golden Retrievers, Basset Hounds, Welsh Corgis, Siberian Huskies, Great Danes, Labrador Retrievers, Doberman Pinschers, American Pit Bull Terriers, and Akitas. Mixed breed dogs were found to be at lower risk, and the authors suggest genetic hetereogeneity (hybrid vigor) as the cause.

Urogenital Disorders

Urinary incontinence is common in spayed female dogs, which can occur soon after spay surgery or after a delay of up to several years. The incidence rate in various studies is 4-20% ^{35,36,37} for spayed females compared to only 0.3% in intact females³⁸. Urinary incontinence is so strongly linked to spaying that it is commonly called "spay incontinence" and is caused by urethral sphincter incompetence³⁹, though the biological mechanism is unknown. Most (but not all) cases of urinary incontinence respond to medical treatment, and in many cases this treatment needs to be continued for the duration of the dog's life. ⁴⁰

A retrospective study found that persistent or recurring urinary tract (bladder) infections (UTIs) were 3-4 times more likely in spayed females dogs than in intact females⁴¹. Another retrospective study found that female dogs spayed before 5 ½ months of age were 2.76 times more likely to develop UTIs compared to those spayed after 5 ½ months of age.⁴²

Depending on the age of surgery, spaying causes abnormal development of the external genitalia. Spayed females were found to have an increased risk of recessed vulva, vaginal dermatitis, vaginitis, and UTIs. ⁴³ The risk is higher still for female dogs spayed before puberty.

Pyometra (Infection of the Uterus)

Pet insurance data in Sweden (where spaying is very uncommon) found that 23% of all female dogs developed pyometra before 10 years of age⁴⁴. Bernese Mountain dogs, Rottweilers, rough-haired Collies, Cavalier King Charles Spaniels and Golden Retrievers were found to be high risk breeds⁴⁴. Female dogs that have not whelped puppies are at elevated risk for pyometra⁴⁵. Rarely, spayed female dogs can develop "stump pyometra" related to incomplete removal of the uterus.

Pyometra can usually be treated surgically or medically, but 4% of pyometra cases led to death⁴⁴. Combined with the incidence of pyometra, this suggests that about 1% of intact female dogs will die from pyometra.

Perianal Fistulas

Male dogs are twice as likely to develop perianal fistulas as females, and spay/neutered dogs have a decreased risk compared to intact ${\rm dogs}^{48}$.

German Shepherd Dogs and Irish Setters are more likely to develop perianal fistulas than are other breeds 46

Non-cancerous Disorders of the Prostate Gland

The incidence of benign prostatic hypertrophy (BPH, enlarged prostate) increases with age in intact male dogs, and occurs in more than 80% of intact male dogs older than the age of 5 years⁴⁷. Most cases of BPH cause no problems, but in some cases the dog will have difficulty defecating or urinating.

Neutering will prevent BPH. If neutering is done after the prostate has become enlarged, the enlarged prostate will shrink relatively quickly.

BPH is linked to other problems of the prostate gland, including infections, abscesses, and cysts, which can sometimes have serious consequences.

Orthopedic Disorders

In a study of beagles, surgical removal of the ovaries (as happens in spaying) caused an increase in the rate of remodeling of the ilium (pelvic bone) 48, suggesting an increased risk of hip dysplasia with spaying. Spaying was also found to cause a net loss of bone mass in the spine 49.

Spay/neuter of immature dogs delays the closure of the growth plates in bones that are still growing, causing those bones to end up significantly longer than in intact dogs or those spay/neutered after maturity⁵⁰. Since the growth plates in various bones close at different times, spay/neuter that is done after some growth plates have closed but before other growth plates have closed might result in a dog with unnatural proportions, possibly impacting performance and long term durability of the joints.

Spay/neuter is associated with a two fold increased risk of cranial cruciate ligament rupture⁵¹. Perhaps this is associated with the increased risk of obesity³⁰.

Spay/neuter before 5 ½ months of age is associated with a 70% increased aged-adjusted risk of hip dysplasia compared to dogs spayed/neutered after 5 ½ months of age, though there were some indications that the former may have had a lower severity manifestation of the disease 42. The researchers suggest "it is possible that the increase in bone length that results from early-age gonadectomy results in changes in joint conformation, which could lead to a diagnosis of hip dysplasia."

In a breed health survey study of Airedales, spay/neuter dogs were significantly more likely to suffer hip dysplasia as well as "any musculoskeletal disorder", compared to intact dogs⁵², however possible confounding factors were not controlled for, such as the possibility that some dogs might have been spayed/neutered because they had hip dysplasia or other musculoskeletal disorders.

Compared to intact dogs, another study found that dogs neutered six months prior to a diagnosis of hip dysplasia were 1.5 times as likely to develop clinical hip dysplasia. 53

Compared to intact dogs, spayed/neutered dogs were found to have a 3.1 fold higher risk of patellar luxation. 54

Geriatric Cognitive Impairment

Neutered male dogs and spayed female dogs are at increased risk of progressing from mild to severe geriatric cognitive impairment compared to intact male dogs⁵⁵. There weren't enough intact geriatric females available for the study to determine their risk.

Geriatric cognitive impairment includes disorientation in the house or outdoors, changes in social interactions with human family members, loss of house training, and changes in the sleep-wake cycle⁵⁵.

The investigators state "This finding is in line with current research on the neuro-protective roles of testosterone and estrogen at the cellular level and the role of estrogen in preventing Alzheimer's disease in human females. One would predict that estrogens would have a similar protective role in the sexually intact female dogs; unfortunately too few sexually intact female dogs were available for inclusion in the present study to test the hypothesis³⁵

CONCLUSIONS

An objective reading of the veterinary medical literature reveals a complex situation with respect to the long-term health risks and benefits associated with spay/neuter in dogs. The evidence shows that spay/neuter correlates with both positive AND adverse health effects in dogs. It also suggests how much we really do not yet understand about this subject.

On balance, it appears that no compelling case can be made for neutering most male dogs to prevent future health problems, especially immature male dogs. The number of health problems associated with neutering may exceed the associated health benefits in most cases.

For female dogs, the situation is more complex. The number of health benefits associated with spaying may exceed the associated health problems in many (not all) cases. On balance, whether spaying improves the odds of overall good health or degrades them probably depends on the age of the dog and the relative risk of various diseases in the different breeds.

The traditional spay/neuter age of six months as well as the modern practice of pediatric spay/neuter appear to predispose dogs to health risks that could otherwise be avoided by waiting until the dog is physically mature, or perhaps in the case of many male dogs, foregoing it altogether unless medically necessary.

The balance of long-term health risks and benefits of spay/neuter will vary from one dog to the next. Breed, age, and gender are variables that must be taken into consideration in conjunction with non-medical factors for each individual dog. Across-the-board recommendations for all dogs do not appear to be supportable from findings in the veterinary medical literature.

REFERENCES

- ¹ Burrow R, Batchelor D, Cripps P. Complications observed during and after ovariohysterectomy of 142 bitches at a veterinary teaching hospital. Vet Rec. 2005 Dec 24-31;157(26):829-33.
- ² Pollari FL, Bonnett BN, Barnsey, SC, Meek, AH, Allen, DG (1996) Postoperative complications of elective surgeries in dogs and cats determined by examining electronic and medical records. Journal of the American Veterinary Medical Association 208, 1882-1886
- 3 Dorn AS, Swist RA. (1977) Complications of canine ovariohysterectomy. Journal of the American Animal Hospital Association 13, 720-724
- ⁴ Pollari FL, Bonnett BN. Evaluation of postoperative complications following elective surgeries of dogs and cats at private practices using computer records, Can Vet J. 1996 November; 37(11): 672–678.
- ⁵ Teske E, Naan EC, van Dijk EM, van Garderen E, Schalken JA. Canine prostate carcinoma: epidemiological evidence of an increased risk in castrated dogs. Mol Cell Endocrinol. 2002 Nov 29;197(1-2):251-5.
- ⁶ Sorenmo KU, Goldschmidt M, Shofer F, Ferrocone J. Immunohistochemical characterization of canine prostatic carcinoma and correlation with castration status and castration time. Vet Comparative Oncology. 2003 Mar; 1 (1): 48
- 7 Weaver, AD. Fifteen cases of prostatic carcinoma in the dog. Vet Rec. 1981; 109, 71-75.
- ⁸ Cohen D, Reif JS, Brodey RS, et al: Epidemiological analysis of the most prevalent sites and types of canine neoplasia observed in a veterinary hospital. Cancer Res 34:2859-2868, 1974
- ⁹ Theilen GH, Madewell BR. Tumors of the genital system. Part II. In:Theilen GH, Madewell BR, eds. Veterinary cancer medicine. 2nd ed.Lea and Febinger, 1987:583–600.
- Glickman LT, Glickman N, Thorpe R. The Golden Retriever Club of America National Health Survey 1998http://www.vet.purdue.edu//epi/golden_retriever_final22.pdf
- 11 Handbook of Small Animal Practice, 3rd ed
- ¹² Hayes HM Jr, Pendergrass TW. Canine testicular tumors: epidemiologic features of 410 dogs. Int J Cancer 1976 Oct 15;18(4):482-7
- ¹³ Ru G, Terracini B, Glickman LT. (1998) Host-related risk factors for canine osteosarcoma. Vet J 1998 Jul;156(1):31-9
- ¹⁴ Cooley DM, Beranek BC, Schlittler DL, Glickman NW, Glickman LT, Waters DJ. Endogenous gonadal hormone exposure and bone sarcoma risk. Cancer Epidemiol Biomarkers Prev. 2002 Nov;11(11):1434-40.
- 15 Moe L. Population-based incidence of mammary tumours in some dog breeds. J of Reproduction and Fertility Supplment 57, 439-443.
- ¹⁶ Ferguson HR; Vet Clinics of N Amer: Small Animal Practice; Vol 15, No 3, May 1985
- ¹⁷ MacEwen EG, Patnaik AK, Harvey HJ Estrogen receptors in canine mammary tumors. Cancer Res., 42: 2255-2259, 1982.
- ¹⁸ Schneider, R, Dorn, CR, Taylor, DON. Factors Influencing Canine Mammary Cancer Development and Postsurgical Survival. J Natl Cancer Institute, Vol 43, No 6, Dec. 1969
- ¹⁹ Feinleib M: Breast cancer and artificial menopause: A cohort study. J Nat Cancer Inst 41: 315-329, 1968.
- ²⁰ Dorn CR and Schneider R. Inbreeding and canine mammary cancer. A retrospective study. J Natl Cancer Inst. 57: 545-548, 1976.
- ²¹ Brodey RS: Canine and feline neoplasia. Adv Vet Sci Comp Med 14:309-354, 1970
- ²² Hayes A, Harvey H J: Treatment of metastatic granulosa cell tumor in a dog. J Am Vet Med Assoc 174:1304-1306, 1979

²³ Norris AM, Laing EJ, Valli VE, Withrow SJ. J Vet Intern Med 1992 May; 6(3):145-53

²⁴ Prymak C, McKee LJ, Goldschmidt MH, Glickman LT. Epidemiologic, clinical, pathologic, and prognostic characteristics of splenic hemangiosarcoma and splenic hematoma in dogs: 217 cases (1985). J Am Vet Med Assoc 1988 Sep; 193(6):706-12

²⁵ Ware WA, Hopper, DL. Cardiac Tumors in Dogs: 1982-1995. J Vet Intern Med 1999;13:95–103.

 $^{^{26}}$ Panciera DL. Hypothyroidism in dogs: 66 cases (1987-1992). J Am Vet Med Assoc. 1994 Mar 1;204(5):761-7

²⁷ Panciera DL. Canine hypothyroidism. Part I. Clinical findings and control of thyroid hormone secretion and metabolism. Compend Contin Pract Vet 1990: 12: 689-701.

²⁸ Glickman LT, Glickman N, Raghaven M, The Akita Club of America National Health Survey 2000-2001. http://www.vet.purdue.edu/epi/akita_final_2.pdf

²⁹ Glickman LT, HogenEsch H, Raghavan M, Edinboro C, Scott-Moncrieff C. Final Report to the Hayward Foundation and The Great Dane Health Foundation of a Study Titled Vaccinosis in Great Danes. 1 Jan 2004. http://www.vet.purdue.edu/epi/great_dane_vaccinosis_fullreport_jan04.pdf

 $^{^{30}}$ Edney AT, Smith PM. Study of obesity in dogs visiting veterinary practices in the United Kingdom. .Vet Rec. 1986 Apr 5;118(14):391-6.

³¹ McGreevy PD, Thomson PC, Pride C, Fawcett A, Grassi T, Jones B. Prevalence of obesity in dogs examined by Australian veterinary practices and the risk factors involved. Vet Rec. 2005 May 28;156(22):695-702.

³² Lund EM, Armstrong PJ, Kirk, CA, Klausner, JS. Prevalence and Risk Factors for Obesity in Adult Dogs from Private US Veterinary Practices. Intern J Appl Res Vet Med • Vol. 4, No. 2, 2006.

³³ Marmor M, Willeberg P, Glickman LT, Priester WA, Cypess RH, Hurvitz AI. Epizootiologic patterns of diabetes mellitus in dogs Am J Vet Res. 1982 Mar;43(3):465-70. ...

³⁴ Moore GE, Guptill LF, Ward MP, Glickman NW, Faunt KF, Lewis HB, Glickman LT. Adverse events diagnosed within three days of vaccine administration in dogs. JAVMA Vol 227, No 7, Oct 1, 2005

³⁵ Thrusfield MV, Holt PE, Muirhead RH. Acquired urinary incontinence in bitches: its incidence and relationship to neutering practices.. J Small Anim Pract. 1998. Dec;39(12):559-66.

³⁶ Stocklin-Gautschi NM, Hassig M, Reichler IM, Hubler M, Arnold S. The relationship of urinary incontinence to early spaying in bitches. J Reprod Fertil Suppl. 2001;57;233-6...

³⁷ Arnold S, Arnold P, Hubler M, Casal M, and Rüsch P. Urinary Incontinence in spayed bitches: prevalence and breed disposition. European Journal of Campanion Animal Practice. 131, 259-263.

³⁸ Thrusfield MV 1985 Association between urinary incontinence and spaying in bitches Vet Rec 116 695

³⁹ Richter KP, Ling V. Clinical response and urethral pressure profile changes after phenypropanolamine in dogs with primary sphincter incompetence. J Am Vet Med Assoc 1985: 187: 605-611.

⁴⁰ Holt PE. Urinary incontinence in dogs and cats. Vet Rec 1990: 127: 347-350.

⁴¹ Seguin MA, Vaden SL, Altier C, Stone E, Levine JF (2003) Persistent Urinary Tract Infections and Reinfections in 100 Dogs (1989–1999). Journal of Veterinary Internal Medicine: Vol. 17, No. 5 pp. 622–631.

⁴² Spain CV, Scarlett JM, Houpt KA. Long-term risks and benefits of early-age gonadectomy in dogs. JAVMA 2004;224:380-387.

⁴³ Verstegen-Onclin K, Verstegen J. Non-reproductive Effects of Spaying and Neutering: Effects on the Urogenital System. Proceedings of the Third International Symposium on Non-Surgical Contraceptive Methods for Pet Population Control http://www.acc-d.org/2006%20Symposium%20Docs/Session%20I.pdf

⁴⁴ Hagman R: New aspects of canine pyometra. Doctoral thesis, Swedish University of Agricultural Sciences, Uppsala, 2004.

⁴⁵ Chastain CB, Panciera D, Waters C: Associations between age, parity, hormonal therapy and breed, and pyometra in Finnish dogs. Small Anim Endocrinol 1999; 9: 8.

⁴⁶ Killingsworth CR, Walshaw R, Dunstan RW, Rosser, EJ. Bacterial population and histologic changes in dogs with perianal fistula. Am J Vet Res, Vol 49, No. 10, Oct 1988.

⁴⁷ Johnston SD, Kamolpatana K, Root-Kustritz MV, Johnston GR, Prostatic disorders in the dog. Anim Reprod. Sci Jul 2;60-61:405-415. .

⁴⁸ Dannuccia GA, Martin RB., Patterson-Buckendahl P Ovariectomy and trabecular bone remodeling in the dog. Calcif Tissue Int 1986; 40: 194-199.

⁴⁹ Martin RB, Butcher RL, Sherwood L,L Buckendahl P, Boyd RD, Farris D, Sharkey N, Dannucci G. Effects of ovariectomy in beagle dogs. Bone 1987; 8:23-31

⁵⁰ Salmeri KR, Bloomberg MS, Scruggs SL, Shille V. Gonadectomy in immature dogs: Effects on skeletal, physical, and behavioral development, JAVMA, Vol 198, No. 7, April 1991.

⁵¹ Whitehair JG, Vasseur PB, Willits NH. Epidemiology of cranial cruciate ligament rupture in dogs. J Am Vet Med Assoc. 1993 Oct 1;203(7):1016-9.

⁵² Glickman LT, Airedale Terrier Club of America, Airedale Terrier Health Survey 2000-2001 http://www.vet.purdue.edu//epi/Airedale%20final%20report_revised.pdf

⁵³ van Hagen MA, Ducro BJ, van den Broek J, Knol BW. Incidence, risk factors, and heritability estimates of hind limb lameness caused by hip dysplasia in a birth cohort of boxers. Am J Vet Res. 2005 Feb;66(2):307-12.

⁵⁴ B. Vidoni, I. Sommerfeld-Stur und E. Eisenmenger: Diagnostic and genetic aspects of patellar luxation in small and miniature breed dogs in Austria. Wien. Tierarztl. Mschr. (2005) 92, p170 – 181

⁵⁵ Hart BL. Effect of gonadectomy on subsequent development of age-related cognitive impairment in dogs. J Am Vet Med Assoc. 2001 Jul 1;219(1):51-6.

Reference Point

Determining the optimal age for gonadectomy of dogs and cats

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Elective gonadectomy of dogs and cats, most commonly performed as an OHE of females and castration of males, is one of the most common veterinary procedures performed in the United States. Increasingly, dog owners and members of the veterinary profession throughout the world have questioned the optimal age for performance of these surgeries or whether they should even be performed as elective surgeries. The objective for the information reported here was to provide a review of the scientific evidence, which could be used by veterinarians to counsel clients appropriately on this issue.

Traditional Age at Gonadectomy

Currently, most veterinarians in the United States recommend that elective gonadectomy be performed in dogs and cats at 6 to 9 months of age. However, there does not appear to be any scientific evidence to document that this is the optimal age. In fact, the age at which pets have traditionally been spayed and neutered has varied through the years and with geographic location. In the early 1900s, OHE was performed at 3 to 6 months of age and castration as early as 4 weeks of age.2 Over time, the recommended age for elective gonadectomy of small animals increased to 6 to 9 months of age. It has been hypothesized that this was the result of an increasing popularity of dogs and cats as pets as American citizens found themselves with more disposable income. a subsequent desire by those pet owners for reproduction control in their animals, and the intent of veterinarians to provide the safest possible anesthesia and surgery for these new "family members." Despite great advances in anesthetic and surgical techniques and multiple studies that provide evidence for the safety of anesthesia and surgery in dogs and cats of younger ages, veterinarians in the United States still cling to the recommendation to perform gonadectomy at 6 to 9 months of age, with the added stipulation that bitches and queens should be spayed before their first estrus.

In some parts of the world, elective gonadectomy is considered unethical and is strongly discouraged or disallowed by professional veterinary associations.² Elective gonadectomy is illegal in at least 1 country.³ In 1 article⁴ published in Europe, elective gonadectomy

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ABBREVIATIONS

OHE
TCC Transitional cell carcinoma
CCL Canial cruciate ligament
FLUTD Feline lower urinary tract disease
BPH Benign prostatic hypertrophy-hyperplasia

is decried as "the tool of despots and tyrants throughout history," and the author of that article claims that gonadectomized dogs are "canine eunuchs, condemned to live their lives in a physical and mental twilight." That author also questions how a profession that publicly declares itself the guardian of animal welfare can, with impunity, perform elective surgery on animals for human convenience.*

Cultural and personal factors, including religious affiliation, ethnic background, intended working life of the animal, urban or rural location of the household, and literacy status, also may be associated with the likelihood that an owner will request gonadectomy for a pet.⁵⁻⁷ Species and sex also play a role; in retrospective surveys, cats are more likely to be spayed or castrated than dogs, and bitches and queens are more likely to have undergone elective gonadectomy than stud dogs or tomests.⁶⁹

Surgical and anesthetic techniques for elective gonadectomy in dogs and cats of various ages are provided in the veterinary literature. 10-12 The reported incidence of postoperative complications in 1,016 dogs and 1,459 cats after elective surgery was 6.1% and 2.6%, respectively, with most of these considered minor problems, including inflammation at the incision site and gastrointestinal tract upset. 13 Complications were more common in dogs that underwent surgery when they were > 2 years of age. 13 In a study 14 in which investigators evaluated complications in 142 dogs undergoing OHE performed by fourth-year veterinary students, incidence of intraoperative complications was 6.3% and incidence of postoperative complications was 14.2%. Again, most of these were minor, including self-resolving hemorrhage and inflammation at the incision site and gastrointestinal tract upset. In that study,14 the high incidence of postoperative complications was associated with an increase in surgery time, which was in turn positively correlated with increasing body weight of the animal. In studies¹⁵⁻¹⁷ in which incidence of intraoperative and postoperative complications for elective gonadectomies performed at various ages was compared, the only com-

plication associated with age at time of surgery was an increased incidence of postoperative infectious disease in dogs undergoing elective gonadectomy when they were < 12 weeks old. This may have been an artifact of the source from which dogs were recruited for the study.¹⁷

Societal Benefits of Elective Gonadectomy

The primary societal benefits of elective gonadectomy in dogs and cats are fewer animals relinquished to humane organizations and the fact that a specific animal's contribution to pet overpopulation is minimized. Multiple studies^{9,18-30} have revealed that sexually intact dogs and cats are more likely to be relinquished to humane organizations than are those that are gonadecto-mized. In only 1 study²¹ was it reported that there was an increased percentage of gonadectomized animals among those relinquished to humane organizations; animals in that study were relinquished for behavioral reasons, and it was considered likely that they had been gonadectomized as a possible treatment for behavioral problems, but with no subsequent improvement after surgery

Millions of dogs and cats are euthanized at humane organizations annually in the United States, with estimates of 5.4 to 9.1 million dogs and 5.7 to 9.5 million cats euthanized in 1990.^{22,23} Crude estimates of annual death rates in dogs and cats are 7.9% and 8.3%, respectively 24 Statistics from humane organizations housing at least 100 animals/y, combined with these death rates, suggest that < 400,000 dogs and cats should be euthanized at humane organizations annually.25 Not all animals euthanized at humane organizations are euthanized because of overpopulation²⁶, however, the aforementioned study²⁵ indicates that > 2 million dogs and cats were euthanized at those shelters alone and substantiates the loss of animal life and stress to workers at humane organizations associated with overpopulation of dogs and cats in the United States.

Sexually intact animals adopted from humane organizations may be returned or may reproduce, both of which would repopulate those shelters. In 1 study,8 36.4% of relinquished animals were from unwanted litters. In a survey²⁴ of dog- and cat-owning households in the United States, 56% of 154 canine litters and 68% of 317 feline litters were unplanned. There is a lack of knowledge about reproduction among animal owners; the most common reason reported for the unplanned canine litters was that the owner did not know the bitch was in heat.24 Up to 57% of bitch owners were unaware that bitches may cycle twice each year, up to 83% of cat owners were unaware that queens are seasonally polyestrous, and up to 61% of dog and cat owners were not certain or truly believed that their pet would be better if it had a litter before OHE was performed 9.27.28

Owners that adopt animals from humane organizations routinely sign a spay-neuter contract. However, compliance with such contracts is typically < 60%.829 Up to 90% of veterinarians support mandatory gonadectomy of dogs and cats prior to adop-tion.³⁰ Few venues exist for educating veterinarians in early-age gonadectomy of dogs and cats, with most being self-taught. 30,51 Enhanced training of veterinarians in early-age gonadectomy and pediatric anesthetic techniques, mandatory gonadectomy of dogs and cats prior to adoption, and increased education of dog and cat owners about small animal reproductive physiology can only be of benefit in addressing these societal issues.

Benefits and Detriments of Elective Gonadectomy for Behavioral Concerns

Sexually dimorphic behaviors are those most commonly displayed by 1 sex, with mounting and urine spraying as primary examples.32 Aggression may be a sexually dimorphic behavior. Most commonly, only those forms of aggression associated with the presence of females in estrus (aggression between females or between males housed with those females) are considered sexually dimorphic. Gonadectomy and the subsequent decrease in gonadal steroid hormones have been correlated with a decrease in sexually dimorphic behaviors. 18.33-37 Likelihood that gonadectomy will impact sexually dimorphic behaviors is not correlated with duration of the problem behavior and may or may not be associated with prior sexual experience of the affected animal ^{35,36,38,41} Trainability of working dogs is not altered by gonadectomy and does not vary with age of the dog at the time of gonadectomy.8

Sexual behavior of male cats makes them extremely undesirable, and often unsafe, household pets.42 A decrease in sexually dimorphic behaviors after castration of male cats is an extremely powerful benefit of elective gonadectomy. Sexual behaviors of queens, bitches, and stud dogs, although still possibly undesirable, are less commonly so severe as to make these animals unten-

able as household pets.

Nonsexually dimorphic behaviors are not typically affected by gonadectomy. One large-scale study43 of dogs revealed a possible increase in noise phobias and decrease in separation anxiety and submissive urination associated with gonadectomy performed before the dogs were 5 months old.

An increase in reactivity toward humans with strange (unfamiliar) dogs and in aggression toward family members has been reported after OHE of bitches in several studies. 44-46 The reason for this possible tendency has not been defined but may be attributable to a decrease in estrogen and oxytocin concentrations, both of which may exert antianxiety effects in some species.47 This tendency also may be a breed-specific phenomenon.

Cognitive function may be altered by gonadectomy. Comparison of the progression of cognitive dysfunction in sexually intact and castrated male dogs revealed a slowing of progression in sexually intact males,18 Sample size was small in that study, with only 6 dogs in the sexually intact male group. Androgen deprivation has been associated with increased amyloid deposition in brains of humans and rodents and with decreased synapses in brains of rodents and nonhuman primates.49 However, in a study⁵⁰ in which investigators directly examined brain tissue for DNA damage, a significantly greater percentage of neurons had extensive DNA damage in sexually intact Beagles than in castrated Beagles between 9 and 10.5 years of age.

Benefits and Detriments of Elective Gonadectomy for Various Conditions

Several conditions in dogs and cats can be impacted by elective gonadectomy, including neoplasia and orthopedic diseases. Knowledge of the benefits and detriments associated with elective gonadectomy enables veterinarians to provide the best counsel to clients and also to promote animal health.

Mammary gland neoplasms—Mammary gland neoplasms are the most common tumors of female dogs, with a reported incidence of 3.4%, and they are the third most common tumors of female cats, with a reported incidence of 2.5%.51 55 Mammary gland neoplasms are the most common types of malignant tumors in dogs.⁵³ Mean percentage of mammary gland tumors in female dogs that are malignant is 50.9%. ^{55,56-58} In female dogs that are malignant is 50.9%. ^{55,56-58} In female dogs that are malignant is 50.9%. male cats, > 90% of mammary gland tumors are malignant. 53.5969 Metastases are reported in up to 77% of dogs with mammary gland carcinomas, with the lungs being the site of metastasis in 30.8% of affected dogs. 61.62 In 1 study, 62 59.7% of dogs in which a mammary gland tumor was diagnosed were euthanized at the time of diagnosis.

Increasing age and breed are risk factors for development of mammary gland neoplasms, with a mean age at diagnosis of approximately 10 years in dogs and cats. 52.63.64 Breeds reported to be at increased risk for developing mammary gland tumors include the Boxer, Brittany, Cocker Spaniel, Dachshund, English Setter, English Springer Spaniel, German Shepherd Dog, Mal-tese, Miniature Poodle, Pointer, Toy Poodle, and Yorkshire Terrier. Cat breeds reported to be at increased risk of tumor development are the Japanese domestic breeds and Siamese (Table 1).52.64.65

Maintenance of sexually intact status is a major risk factor for development of mammary gland tumors in dogs and cats. 60.66 Overall, sexually intact dogs and cats have 7 times the risk of developing mammary gland neoplasms when they get older, compared with the risk for spayed dogs and cats. 67 Compared with the incidence in sexually intact dogs, dogs spayed before their first estrus have a 0.5% risk, dogs spayed after 1 estrus have an 8.0% risk, and dogs spayed after 2 estrous cycles have a 26.0% risk of developing mammary gland neoplasms when they get older.68 However, performing an OHE may even have a substantial sparing effect in older dogs, with a reduced but still evident re duction for mammary gland neoplasms in dogs spayed as late as 9 years of age.

An exact cause-and-effect relationship between sexually intact status and mammary gland neoplasia has not been defined Estrogen and progesterone have direct and indirect stimulatory effects on mammary gland tissue, and receptors for both hormones have been identified in normal and neoplastic mammary gland tissues. 69-71 In 1 report, 60 it was suggested that mammary gland neoplasms may be more likely to develop in bitches that had overt pseudopregnancy more than 3 times during their life, which would support the hypothesis that there is a hormonal effect or a direct effect of malignant transformation of metabolically active mammary gland tissue.

Prostatic neoplasms—The reported incidence of prostatic tumors in dogs is 0.2% to 0.6%, and prostatic neoplasms in dogs are almost always malignant adenocarcinomas. (2-)4 There is neoplastic differentiation in tissues of ductal or urothelial origin, which are androgen-independent tissues.⁷⁵ However, castrated dogs are at an increased risk for development of prostatic neoplasms, with the increase in risk ranging from 2.4 to 4.3 times that of sexually intact male dogs (Table 2).72.74.76 Mean age of dogs at diagnosis is approximately 10 years, with slightly younger dogs having prostatic adenocarcinoma with metastases to bones. 4.77,78 An exact cause-and-effect relationship has not been defined, but it has been suggested that deprivation of androgens does not act to initiate neoplasia; rather, androgen deprivation permits progression of disease

Other types of tumors—Testicular tumors are the second most common tumor type in dogs, with a reported incidence of 0.9%. Mean age of dogs at diagnosis is approximately 10 years. 33,64.79 Most tumors are readily diagnosed during physical inspection. Malignancy is considered low for all types of testicular tumors; therefore, castration is curative. 80

Ovarian and uterine tumors are uncommon in dogs and cats. Although malignant tumors of both tissues have been reported, metastasis is rare and OHE is curative in most situations.81-84

Table 1 - Benefits and detriments of OHF for various conditions in female cats.

| ed when spayed | Yes* |
|----------------|--|
| Low No | No |
| | No |
| | |
| 2.6% No. | No |
| | No. |
| | |
| 0.5% No | No Yest |
| | ed when spayed a pirst estrus Low No ses with age No 2.6% No No 0.6% No |

Table 2 Benefits and detriments of gonadectorry for various conditions in male dogs.

| Condition | Incidence | Substantial morbidity? | Specific breeds at risk? |
|--------------------------|---------------------------|------------------------|-----------------------------|
| Benefits | | | |
| Testicular neoplasms | 0.9% | Nio | No |
| BPH or prostatitis | 75% 80% by 6 years of age | No | No |
| Detriments | | | |
| Complications of surgery | 6.1% | No | No |
| Prostatic neoplasms | 0.2% 0.6% | Yes | Nio |
| TCC | < 1% | No | Yes* |
| Osteosarcoma | 0.2% | Yes | Yest |
| Hemangiosarcoma | 0.2% | Yes | Yest |
| CCL rapture | 1.8% | Yes | Yes§ |
| Obesity | 2.8% | No | Yesli |
| Diabetes mellitus | 0.5% | No | Yes¶ |

*Airodale Terrier, Beagle, Collie, Scottish Terrier, Shetland Sheepdog, West Highland White Terrier, and Wire Fox Terrier. †Doberman Pinscher, Great Dane, Irish Setter, Irish Wolfhound, Rottweiler, and Saint Bernard. †Boxer, English Setter, German Shepherd Dog, Golden Retriever, Great Dane, Labrador Retriever, Pointer, Poodle, and Siberian Husky \$Akita, American Staffordshire Terrier, Chesapeake Bay Retriever, German Shepherd Dog, Golden Retriever, Labrador Retriever, Mastiff, Neapolitian Mastiff, Newfoundland, Poodle, and Saint Bernard. IlBeagle, Cairn Terrier, Cavalier King Charles Spaniel, Cocker Spaniel, Dachshund, Labrador Retriever, ¶Airedale Terrier, Cocker Spaniel, Dachshund, Doberman Pinschen, Golden Retriever, Irish Setter, Miniature Schnauzer, Pomeranian, and Shetland Sheepdog.

The most common tumor of the urinary tract of dogs is TCC of the bladder. Ph-88 Overall incidence of TCC in dogs is reported to be, at most. 1% of all malignant tumors. Ph. Breeds at increased risk for development of a TCC include the Airedale Terrier, Beagle, Collie, Scottish Terrier, Shetland Sheepdog, West Highland White Terrier, and Wire Fox Terrier (Table 3). Gonadectomized animals have a risk for development of TCC approximately 2 to 4 times that of sexually intact animals. Ph. 85.86 An exact cause-and-effect relationship has not been defined.

Osteosarcoma is a highly malignant tumor, with a reported incidence of 0.2%.⁶⁴ Risk of development of osteosarcoma increases with age and may increase with increasing body weight.^{91,9} Breeds reported to be at increased risk for development of an osteosarcoma include the Doberman Pinscher, Great Dane, Irish Setter, Irish Wolfhound, Rottweiler, and Saint Bernard.^{91,93} In 1 study⁹² in which historical data that consisted of owners' assessments of body condition score and body weight were used for analysis, incidence of osteosarcoma was not correlated with body weight. However, owner assessment of body condition score is poorly correlated with veterinarian assessment of body condition score.⁹⁴

Gonadectomy can increase the risk of development of osteosarcoma by 1.3 to 2.0 times. $^{01.95}$ In 1 study 92 in which investigators evaluated 683 purebred Rottweilers, there was a significant increase in the incidence of osteosarcoma in female and male dogs that had undergone gonadectomy when < 1 year of age, however, the overall incidence of osteosarcoma in this population of dogs was much higher than that in the general population, which suggested a hereditary component. Furthermore, life span of dogs did not differ (mean \pm SD life span of sexually intact and castrated male dogs was 9.3 ± 2.5 years and 9.2 ± 2.5 years, respectively) or was noticeably increased (mean life span in sexually increased)

ally intact and spayed female dogs was 7.5 \pm 2.4 years and 9.8 \pm 2.4 years, respectively) in gonadectomized dogs. ⁹² An exact cause-and-effect relationship has not been defined.

Hemangiosarcoma is the most common cardiac tumor in dogs, with a reported incidence of 0.2%. Breeds at increased risk for development of hemangiosarcoma include the Boxer, English Setter, German Shepherd Dog, Golden Retriever, Great Dane, Labrador Retriever, Pointer, Poodle, and Siberian Husky, with large breeds (in general) at increased risk, compared with the risk for small breeds. For both cardiac and splenic hemangiosarcoma, relative risk is increased for gonadectomized animals, with spayed females reportedly having 2.2 times the risk of splenic hemangiosarcoma and 5 times the risk for cardiac hemangiosarcoma, compared with the risk for sexually intact females, and castrated males having 2.4 times the risk, compared with the risk for sexually intact males. An exact cause-and-effect relationship has not been defined.

Orthopedic abnormalities—Postmenopausal women or those who have undergone OHE have explicit concerns about osteoporosis. However, there is no decrease in mineral density of bone in dogs after OHE. 99 101

Timing of closure of the physes of long bones is controlled in part by gonadal hormones. In both dogs and cats, gonadectomy at any age prior to physeal closure delays that closure and is associated with statistically significant, although not readily visible or clinically relevant, lengthening of associated long bones. Movement However, no specific correlation has been found between age at gonadectomy and incidence of long-bone fractures, including physeal fractures. In 1 study. There was an increase in the incidence of capital physeal fractures in the femurs of castrated male cats; however, the cats with fractures were also overweight.

Table 3—Benefits and detriments of OHE for various conditions in female does

| Condition | Incidence | Substantial morbidity? | Specific breeds at risk? |
|---------------------------|---|------------------------|-----------------------------|
| Benefits | | | |
| Mammary gland neoplasms | 3.4% in all dogs; greatly reduced when spayed before first estrus | Yes | Yes* |
| Ovarian or uterine tumors | Low | No | No |
| Pyometra | 15.2% by 4 years of age; | Yes | |
| · yomotru | 23% to 24% by 10 years of age | 105 | Yest |
| Detriments | or age | | |
| Complications of surgery | 6.1% | No | No |
| Aggression | Variable | Potentially | Yes‡ |
| TCC | < 1% | No | Yes§ |
| Osteosarcoma | 0.2% | Yes | Yesil |
| Hemangiosarcoma | 0.2% | Yes | Yes¶ |
| CCL rupture | 1.8% | Yes | Yes# |
| Obesity | 2.8% | No. | Yes*** |
| Diabetes mellitus | 0.5% | No | Yestt |
| Urinarγ incontinence | 4.9% 20.0%; increased wi spayed at < 3 months of age | | Yes‡‡ |

*Boxer, Brittany, Cocker Spaniel, Dachshund, English Setter, English Springer Spaniel, German Shepherd Dog, Maltese, Miniature Poodle, Pointer, Toy Poodle, and Yorkshire Terrier, †Bernese Mountain Dog, Cavalier King Charles Spaniel, Chow Chow, Collie, English Cocker Spaniel, Golden Betriaver, Rottweiler, and Saint Bernard. ‡English Springer Spaniel, Sairedale Terrier, Beagle, Collie, Scottish Terrier, Shetland Sheepdog, Wast Highland White Terrier, and Wire Fox Terrier. ‡Doberman Pinscher, Great Dane, Irish Setter, Irish Wolfhound, Rottweiler, and Saint Bernard. †Boxer, English Setter, German Shepherd Dog, Golden Retriever, Great Dane, Labrador Retriever, Pointer, Poodle, and Siberian Husky. #Aktra, American Staffordshire Terrier, Chesapeake Bay Retriever, German Shepherd Dog, Golden Retriever, Labrador Retriever, Hassiff, Neapolutan Mastiff, Newfoundland, Poodle, and Saint Bernard. **Beagle, Caim Terrier, Cavalier King Charles Spaniel, Cocker Spaniel, Dachshund, and Labrador Retriever. ††Airedale Terrier, Cocker Spaniel, Dachshund, Doberman Pinscher, Golden Retriever, Irish Setter, Miniature Schnauzer, Pomeranian, and Shetland Sheepdog. ‡‡Boxer, Doberman Pinscher, Giant Schnauzer, Irish Setter, Old English Sheepdog, Rottweiler, Springer Spaniel, and Weimeraner.

Hip dysplasia is a hereditary condition in dogs that affects females and males with equal frequency and can be controlled (to some extent) by environmental factors, including diet. ¹⁰⁶⁻¹¹¹ The reported incidence of hip dysplasia is 1.7%, with an increased incidence in large-and giant-breed dogs, most particularly in the Chesapeake Bay Retriever, English Setter, German Shepherd Dog, Golden Retriever, Labrador Retriever, Samoyed, and Saint Bernard breeds. ¹¹² In 1 large study⁴³ of 1,842 dogs, there was an increased incidence of hip dysplasia in dogs spayed or castrated prior to 5 months of age; however, it was not clear whether the diagnosis of hip dysplasia was confirmed by a veterinarian in all affected dogs.

Rupture of the CCL is more common in women than in men and may be more likely to occur during certain phases of the menstrual cycle, which suggests a hormonal effect on joint stability. Dog breeds reported to be at increased risk of CCL rupture include the Akita, American Staffordshire Terrier, Chesapeake Bay Retriever, German Shepherd Dog. Golden Retriever, Labrador Retriever, Mastiff, Neapolitan Mastiff, Newfoundland, Poodle, Rottweiler, and Saint Bernard. 114,115 Reported incidence of CCL rupture is 1.8%, and it reportedly is more prevalent in gonadectomized female and male dogs than in sexually intact dogs. 115,117 An exact cause-and-effect relationship has not been defined, but heredity plays a role in the predisposition toward CCL injury, as might body weight and body condition score. To my knowledge, there have been no studies for which the results would implicate alterations in phy-

seal closure with subsequent asynchrony of long-bone growth and abnormalities in joint formation as a cause of CCL rupture in dogs. [15,118]

Obesity—Obesity is the most common nutritional disorder of dogs and cats, with a reported incidence of 2.8% among the entire dog population. ¹¹⁹ It is a multifactorial problem. Risk factors include breed, with an increased incidence of obesity in Beagles, Cairn Terriers, Cavalier King Charles Spaniels, Cocker Spaniels, Dachshunds, and Labrador Retrievers; housing; increasing age⁶; ownership by an overweight person or a person ≥ 40 years old; and, possibly, sex of the dog. ^{94,119} ¹²²

The most commonly reported risk factor for obesity is gonadectomy, with spayed or castrated dogs and cats much more commonly designated by veterinarians as being overweight or obese, compared with the weight designations for sexually intact animals. ^{33,201 127} in 1 study. ¹³⁸ 34% of castrated male and 36% of spayed female dogs were considered overweight or obese. It is unclear whether age at the time of gonadectomy has an effect on subsequent obesity. Studies ^{34,10,10,10} in dogs failed to detect differences in food intake, body weight, or depth of back fat when comparing dogs gonadectomized at 7 or 8 weeks of age and dogs gonadectomized at 7 months of age. A retrospective study ¹³ of 1,842 dogs revealed a decrease in the incidence of obesity in dogs gonadectomized prior to 5 months of age when compared with those gonadectomized at > 5 months of age. Similarly, although cats are more likely than dogs

to become obese after gonadectomy, no correlation has been found between age at gonadectomy and final body weight or amount of body fat.³⁴

Metabolic rate decreases after gonadectomy in cats. ^{125,126} A cause-and-effect relationship between gonadectomy and obesity in dogs is less clearly defined. Spayed female dogs have an increase in food intake and increase in indiscriminate appetite after OHE, compared with those of sham-operated or age-matched control dogs. ^{44,129} Estrogen may act as a satiety factor, which would explain these changes. ¹²² This does not address the correlation between obesity and castration in male dogs. In both dogs and cats, obesity is not a mandatory consequence of gonadectomy; instead, it is controllable with an appropriate diet, feeding regimen, and exercise regimen. ¹³⁰

Urinary tract disorders—Spayed female dogs reportedly have an increased risk of developing urinary tract infections. ^{43,131} A cause-and-effect relationship has not been defined.

Female dogs spayed before onset of puberty may be more likely to maintain a juvenile or recessed vulva. In 1 study. 104 bitches spayed at 7 weeks of age had a vulva with a more immature appearance, compared with the vulva in bitches spayed at 7 months of age. It is the author's experience that bitches spayed as adults will have vulvar atrophy, which achieves the same result. A juvenile vulva in an otherwise healthy dog is of no clinical relevance. Overweight bitches with a recessed vulva, especially those with concurrent urinary incontinence, are more likely to develop perivulvar dermatitis.

Male dogs castrated at 7 weeks of age had less pe-

Male dogs castrated at 7 weeks of age had less penile development than did dogs castrated when they were older. 102 Male cats castrated before onset of puberty may have a decreased ability to extrude the penis. 132.133 Clinical relevance of this phenomenon is not known.

Clinical relevance of this phenomenon is not known.

Felme lower urmary tract disease is a syndrome consisting of hematuria, dysuria or pollakiuria, and possible urethral obstruction and is most commonly classified as idiopathic. The reported incidence of FLUTD is 0.6%. 134 Despite numerous vehemently declared anecdotes of an increase in the incidence of urethral obstruction in male cats castrated when young, numerous studies 151.112.113 have failed to detect a correlation between gonadectomy of cats at any age and a decrease in diameter of the urethra or an increase in incidence of FLUTD, with or without urethral obstruction. In I large study, 136 investigators identified gonadectomy as a risk factor for development of FLUTD in both female and male cats and also identified an increased risk of development of FLUTD in overweight or obese cats. In that study, sexually intact female cats had a relatively reduced risk for development of FLUTD.

Urethral sphincter mechanism incompetence, formerly known as estrogen-responsive urinary incontinence, is a common problem of spayed female dogs. ¹³⁷ ¹³⁹ The condition is evident with equal frequency in ovariohysterectomized or ovariectomized female dogs, with the reported incidence ranging from 4.9% to 20.0%, ^{13,138-140} Studies ^{17,141} have failed to detect a correlation between age at time of OHE and likelihood of developing incontinence. In a study ¹³ of 983 female dogs, bitches were significantly less likely to develop

incontinence when spayed at > 3 months of age. Other risk factors include body weight, with dogs weighing > 20 kg (44 lb) at increased risk; breed, with Boxers, Doberman Pinschers, Giant Schmauzers, Irish Setters, Old English Sheepdogs, Rottweilers, Springer Spaniels, and Weimeraners at increased risk and Labrador Retrievers at decreased risk in European studies; and urethral length or resting position of the urinary bladder. ^{137,140,142,145} An exact cause-and-effect relationship has not been defined, with research currently focusing on altered gonadotropin secretion after gonadectomy. ^{146,150} Typically, urethral sphincter mechanism incompetence is easily controlled with medical treatments.

Adrenal gland disease—To the author's knowledge, there are no reports of an increase in the incidence of adrenal gland disease associated with sexually intact status in dogs and cats. In the United States, almost all ferrets are gonadectomized when extremely young; the incidence of adrenal gland disease in ferrets is higher in the United States than in European countries where ferrets are not routinely spayed or castrated. [51,152] In 1 study [52] in Europe, a correlation was detected between age at gonadectomy and age at onset of adrenal gland disease, with ferrets gonadectomized at a younger age having clinical signs of adrenal gland disease earlier in life. Sexually intact ferrets also have adrenal gland disease. [53] Possible causes for this include lack of down-regulation of sex steroids or an increase in circulating concentrations of gonadotropins that causes adrenal gland hyperplasia and possibly contributes to neoplastic transformation. [54-156]

Pyometra—Incidence of pyometra in dogs and cats in the United States has not been reported, perhaps because of the prevalence of OHE in these species before they reach an age when they would be likely to develop pyometra. In other countries, 15.2% and 23% to 24% of bitches developed pyometra by 4 and 10 years of age, respectively. ^{157,158} Pyometra is more common in nulliparous bitches than in bitches with a history of carrying a pregnancy successfully to term. ^{158,150} There is a significant likelihood that cats will have clinical evidence of uterine disease when queens reach 5 years of age. ¹⁵⁰ Dog breeds reported to be at increased risk of developing pyometra include the Bernese Mountain Dog, Cavalier King Charles Spaniel, Chow Chow, Collie, English Cocker Spaniel, Golden Retriever, Rottweiler, and Saint Bernard, ^{158,150} In animals with pyometra, OHE is curative, with reported mortality rates of 0% to 17% in dogs and 8% in cats. ^{161,162}

Nonneoplastic prostatic disease—Benign prostatic hypertrophy-hyperplasia is a common disorder in sexually intact male dogs. In 1 study, ¹⁶³ investigators evaluated male dogs. Of 300 sexually intact male dogs, 231 (63.4%) had BPH; all castrated male dogs in that study had profound prostatic atrophy. Development of BPH is positively correlated with age. ¹⁶⁴⁻¹⁶⁶ By 2.4 years of age, half of all sexually intact dogs will have histologic or clinical evidence of BPH, with the incidence increasing to 75% to 80% by 6 years of age and 95% to 100% by 9 years of age. ^{164-166,167} In addition, BPH predisposes dogs to prostatitis. ¹⁶⁸ Neither BPH nor prostatitis is commonly associated with substantial morbidity, and

castration is an integral part of the treatment of both conditions. 169,170

Endocrine disorders—The reported incidence of diabetes mellitus in dogs is $0.5\%.^{1/4}$ Risk factors include breed, with Miniature Poodles, Miniature Schnauzers, Pugs, Samoyeds, and Toy Poodles at increased risk; sex, with female dogs more commonly affected than male dogs; and increasing age. 171,172 In 1 study,172 a possible increase in the risk of developing diabetes mellitus was detected in castrated male dogs; however, it was not defined whether this could have been as sociated with obesity in these animals. In cats, the reported incidence of diabetes mellitus is 0.4% and risk factors include breed, with Burmese cats at increased risk; sex, with males at increased risk; and increasing age. 173-175 Gonadectomized male and female cats have an increased risk, with gonadectomized cats having 8.7 times greater odds of developing diabetes mellitus than for sexually intact cats.1/3,1

The incidence of hypothyroidism in dogs is 0.2% to 0.3%. ^{176,177} A breed predisposition has been described for the Airedale Terrier, Cocker Spaniel, Dachshund, Doberman Pinscher, Golden Retriever, Irish Setter, Miniature Schnauzer, Pomeranian, and Shelland Sheepdog breeds. ^{176,177} Those studies ^{176,177} have revealed an increased risk of development of hypothyroidism for spayed female and castrated male dogs, compared with the risk for sexually intact dogs. A cause-and-effect relationship has not been defined. Hypothyroidism typically is easily controlled with medical treatment.

Life span—Life expectancy at birth for women in the United States is 80.4 years, whereas that for men is 75.2 years. ¹⁷⁸ Results for dogs vary, ^{179,181} with females living longer than males in some studies and the reverse being found in other studies. Negative correlations have been detected between body weight and longevity and between height and longevity in dogs. 182 Several studies 179-181 have revealed an increase in longevity for gonadectomized animals when compared with that for sexually intact animals. In sockeye salmon, life span is significantly longer in fish castrated before gonadal development. 103 Results of these studies argue against the evolutionary theory, which holds that it is not prudent for a population to carry individuals that have aged past reproductive usefulness. 50 In dogs and cats, this may be a reflection of enhanced care of animals by owners who have made the investment of surgery or a decrease in risk-associated behaviors (such as roaming) in gonadectomized animals.

Conclusions

How does a veterinarian reconcile all of these data to make the best possible recommendation regarding optimal age at which to neuter male and female dogs and cats? The author provides the following assertions:

Animals housed at humane societies should be treated as a population. Societal benefit resulting from gonadectomy of unowned dogs and cats in the United States outweighs all other concerns. Male and female dogs and cats should be spayed or castrated before being offered for adoption by humane organizations.

Pets should be considered individually, with the understanding that for these pets, population control is a less important concern than is health of each animal. Dogs and cats should be maintained as household pets. Responsible owners should ensure that their pets are provided appropriate and regularly scheduled veterinary care.

The behavior of most sexually intact male cats makes them undesirable or dangerous as pets. Because castration substantially reduces these sexually dimorphic behaviors, it is recommended that all male cats not intended for breeding be castrated prior to puberty and that all breeding males be castrated as soon as their use as a breeding male has ceased.

For female cats and male and female dogs, veterinarians and owners must consider the benefits and detriments of gonadectomy for each animal (Tables 1-3). Factors to be considered include incidence of various conditions associated with gonadectomy; degree of morbidity, with substantial morbidity defined as a condition prevalent in > 1% of the population, associated with > 50% of the malignancy or mortality rates, or not easily controlled by noninvasive treatments or good husbandry; breed; and intended working or breeding life of each animal.

As an example, consider a discussion between a veterinarian and the owner of an 8-week-old female Labrador Retriever that is not intended for breeding. This dog would benefit greatly from OHE before her first estrus as a means of preventing mammary gland tumors, which are extremely common and cause substantial morbidity (Table 3). Because of her breed, detriments of OHE include an increased predisposition to CCL injury, hemangiosarcoma, and obesity. However, there is a low incidence of hemangiosarcoma, and obesity can be readily controlled with good husbandry, which leaves CCL injury as the most important possible detriment. Because the incidence of CCL rupture is lower than that of mammary gland neoplasia, a veterinarian may choose to recommend OHE and educate the owner about maintenance of optimal body condition and other management techniques that will minimize potential for CCL injury. An OHE should be performed before the dogs first estrus. To minimize the potential for development of urinary incontinence, the veterinarian may choose to wait to perform the OHE until after the dog has reached 3 months of age.

The information provided here on the risks and detriments of gonadectomy is not intended to promote or to minimize the importance of gonadectomy as a means of controlling animal populations or possible impacts on animal health or behavior of a specific animal. The veterinary profession recognizes the need for individual assessment of risk and benefit when evaluating vaccination protocols for animals. Elucidation of the genome in various species may lead to individualized diagnostic and treatment plans for each animal in the future. It behooves us as veterinarians dedicated to the provision of the best possible care for animals to educate clients and evaluate each animal carefully when making rec-

ommendations regarding gonadectomy.

- Daniels R, Canine Companions for Independence, Delaware, Ohio: Personal communication, 2002. Habn KA, Vonderhaar MA. Teclaw RF. An epidemiological eval-
- uation of 1202 dogs with testicular neoplasia (abstr). J Vet Intern Med 1992;6:121.

References

- Greenfield CL, Johnson AL, Schaeffer DJ. Frequency of use of various procedures, skills, and areas of knowledge among veter marians in private small animal exclusive or predominant practice and proficiency expected of new veterinary school graduates. J Am Vet Med Assoc 2004;224:1780-1787.
- Salmeri KR, Olson PN, Bloomberg MS. Elective gonadectomy in dogs: a review. J Am Vet Med Assoc 1991;198:1183-1192. Gunzel-Apel AR. Early castration of dogs and cats from the
- point of view of animal welfare. Disch Tierarzil Wochenschr 1998:105:95-98
- Coffey DJ. Sexual mutilation. Vet Times 1998;Dec:34. Eze CA, Eze MC. Castration, other management practices and socio-economic implications for dog keepers in Nsukka area, Enugu State, Nigeria. Frev Vet Med 2002;55:273–280. Manning AM, Rowan AN. Companion animal demographics
- and sterilization status: results from a survey in four Massachu setts towns. Anthrozoos 1992;5:192-201.
- Mahlow JC. Estimation of the proportions of dogs and cats that
- are surgically sterilized. J Am Vet Med Assoc 1999;215:640-643. Alexander SA, Shane SM. Characteristics of animals adopted from an annual control center whose owners complied with a spaying/neutering program. J Am Vet Med Assoc 1994;205:472=
- New JG. Salman MD, Scarlett JM, et al. Shelter relinquishment. characteristics of shelter-relinquished animals and their owners compared with animals and their owners in US per-owning households. J Appl Anim Welf Sci 2000;3:179-201. Howe LM. Surgical methods of contraception and sterilization.
- Theriogenology 2006;66:300-309.

 Howe LM. Prepubertal gonadectomy in dogs and cats—part I. Compand Contin Educ Pract Vet 1999;21:103–111.
- Howe LM. Prepubertal gonadectomy in dogs and cats—part II. Compend Contin Educ Pract Vet 1999 21:197-201 Pollari FL, Bonnett BN, Bamsey SC, et al. Postoperative com-
- plications of elective surgeries in dogs and cats determined by examining electronic and paper medical records. *J Am Vet Med Assoc* 1996;208:1882–1886.
- Burrow R, Batchelor D, Cripps I: Complications observed during and after ovariohysterectomy of 142 bitches at a veterinary teaching hospital. *Vet Rec* 2005;157:829–833. Howe LM. Short-term results and complications of prepubertal gonadectomy in cars and dogs. *J Am Vet Med Assoc* 1997;211:57-85.
- Howe LM, Slater MR, Boothe HW, et al. Long-term outcome of gonadectomy performed at an early age or traditional age in cats. J Am Vet Med Assoc 2000;217:1001–1005.
- Howe LM, Slater MR, Boothe HW, et al. Long-term outcome of gonadectomy performed at an early age or traditional age in dogs. J Am Vet Med Assoc 2001;218:217–221.
 Patronek GJ, Glickman LL, Beck AM, et al. Risk factors for re-
- linquishment of dogs to an animal shelter. J Am Vet Med Assoc
- Mondelli F, Previde EP, Verga M, et al. The bond that never developed: acloption and relinquishment of dogs in a rescue shelter. J Appl Anim Welf Sci 2004;7:253–200.
- Patronek GJ, Glickman LL, Beck AM, et al. Risk factors for relinquishment of cats to an animal shelter. J Am Vet Med Assoc 1996/209/582 588
- Salman MD, Hutchison J, Ruch-Gallie R, et al. Behavioral reasons for relinquishment of dogs and caus to 12 shelters. J Appl
- Anim Welf Sci 2000;3:93–106. Nassar R. Talboy J. Moulton C. Animal shelter reporting study 1990. Englewood, Colo: American Humane Assoc, 1992;5.
- National Council on Pet Population Study and Policy National shelter census. 1994 results. Fort Collins, Colo: National Council on Pet Population Study and Policy, 1994;1-2

- New JC, Keich WJ, Hutchison JM et al. Birth and death rate estimates of cats and dogs in US households and related factors. J Appl Anim Welf 8.7 2004;7:229—241.
- National Council on Pet Population Study and Policy, Shelter Statistic survey, 1994-1997, Available at www.petpopulation org. Accessed Jun 2, 2007.
- Kass PH. New JG. Scarlett JM, et al. Understanding animal companion surplus in the United States: relinquishment of non-adoptables to animal shelters for euthanasia. J Appl Anim Welf Sci 2001;4:237–248.
- Scarlett JM, Salman MD, New JG, et al. The role of veterinary
- practitioners in reducing dog and car relinquishments and en-thanasias. J Am Vet Med Assoc 2002;220:306–311. Scarlett JM, Sahnan MD, New JC, et al. Reasons for relinquish-ment of companion animals in US animal shelters: selected health and personal issues. J Appl Anim Welf Sci 1999;2:41–57.
- Eno M, Fekety S. Early age spay/neuter: a growing consensus. Shelter Sense 1993; Nov: 1–7.
- Spain CV, Scarlett JM, Cully SM. When to neuter dogs and cats: a survey of New York state veterinarians' practices and beliefs. J Am Anim Hosp Assin 2002;38:482-488.
- Root Kustritz MV, Johnston SD, Lieberman LL. Availability of training for prepuberal gonadectomy at North American veterinary colleges. J Am Vet Med Assn. 2000;216:1366–1567. Hart BL, Eckstein RA. The role of gonadal hormones in the
- occurrence of objectionable behaviours in dogs and cats. Appl Anim Behav Sci 1997;52:331-344.
- Stubbs WP, Bloomberg MS, Scruggs SL, et al. Effects of prepubertal gonadectomy on physical and behavioral development in cats. J Am Vet Med Assoc 1990;200:1864-18/1. Spain CV, Scarlett JM, Houpt KA. Long-term risks and ben-
- elits of early age gonadecromy in cats. J Am Vet Med Association 2004;224:372-379.
- Hopkins SG, Schubert TA, Hart BL. Castration of adult male dogs: effects on roaming, aggression, urine marking, and mount
- ing J Am Vet Med Assoc 1976;168:1108-1110. Nielsen JC, Eckstein RA, Hart BL. Effects of castration on problem behaviors in male dogs with reference to age and duration
- of behavior, J Am Vet Med Assoc 1997;211:180–182. Hatt BI, Barrett RF. Effects of castration on lighting, foaming, and urine spraying in adult male cats. J Am Vet Med Assoc 1973;163:290–292.
- Hart BL, Cooper L. Factors relating to urine spraying and lighting in prepubertally gonadecromized cats. J Am Vet Med Assoc 1984;184:1235–1258.
- Rosemblatt JS, Aronson LR. The decline of sexual behavior in male cats after castration with special reference to the role of prior sexual experience. *Echavior* 1958;12:285–338.
- LeBoeuf BJ. Copulatory and aggressive behavior in the prepu-
- berally castrated dog. *Horm Behav* 1970,1:127–136. Sakata JT, Jupta A, Gonzalez-Lima F, et al. Heterosexual housing increases the retention of courtship behavior following castra tion and elevates metabolic capacity in limbic brain nuclei in male whiptail lizards, Chemidopherus inornatus. Horm Behav 2002.42.263 273
- Root Kustritz MV. Elective gonadectomy in the cat. Felme Pract 1996;24(6):36-39
- Spain CV, Scarlett JM, Houpt KA, Long term risks and ben elits of early-age gonadectomy in dogs. J Am Vet Med Assoc
- CHIS of Carry-age gonalectomy in dogs. J Am set Real Assec 2004;224:380-387.

 CTarrell V, Peachey E, Behavioural effects of ovariohysterectomy on bitches. J Small Anim Pract 1990;31:395-398.

 Kim HH, Yeon SC, Houpi KA, et al. Effects of ovariohysterectomy.
- my on reactivity in German Shepherd Dogs. Vet J 2006;172:154-
- Reisner IR. Dominance-related aggression of English Springer Spaniels: a review of 53 cases. *Appl Anim Behav Sci* 1993;37:83
- McCarthy MM, McDonald EH, Brooks PJ, et al. An anxiolytic action of exytocin is enhanced by estrogen in the mouse. Physiof Behav 1997;00:1209–1215.

 Hart EL. Effect of gonadectomy on subsequent development of
- age-related cognitive impairment in dogs. J Am Vet Med Asso 2001;219:51-56.

- Janowsky JS. The role of androgens in cognition and brain aging
- in men. Neuroscience 2006;138:1015–1020.
 Waters DJ, Shen S, Glickman LT. Life expectancy, antagonistic pleiotropy, and the testis of dogs and men. Prostate 2000;43:272–
- Fidler IJ, Brodey RS. The biological behavior of canine mammary neoplasms. J Am Vet Med Assoc 1967;151:1311-1318.
- Verstegen J. Onchin K. Mammary tumors in the queen, in Proceedings. Annu Conf Soc Theriogenol 2003;239–245.
 Doin CR. Taylor DON, Fiye FL, et al. Survey of animal neo-plasms in Alameda and Contra Costa counties. California. 1. Methodology and description of cases, J Natl Cancer Inst. 1968; 40:295-305.
- Moe 1. Population based incidence of manimary tumors in
- some dog breeds. J Reprod Fertil Suppl 2001;57:439–443.
 Richards HG, McNeil PE, Thompson H, et al. An epidemio-logical analysis of a canine-biopsies database compiled by a diagnostic histopathology service. Prev Vet Med 2001;51:125
- 56. Cotchin E. Neoplasins in small animals. Vet Rec 1951;63:67-
- Brodey RS, Goldschmidt MH, Roszel JR. Canine mammary
- gland neoplasms. J Am Anim Hosp Assoc 1983;19:61–90. Moulton JE, Taylor DON, Dorn CR, et al. Canine mammary tumors. Pathol Vet 1970;7:289-320.
- Hampe JF, Misdorp W, Tumouis and dysplasias of the mammary gland. Ball World Health Organ 1974;50:111-133. Hayes HM, Milne KI. Mandel CP. Epidemiological features of
- feline mammary carcinoma. Vet Rec 1981;108:476-479. Moulton JE, Rosenblatt LS, Goldman M. Manmary tumors in a
- colony of Beagle dogs. Vet Pathol 1986;23:741–740. Misdorp W, Hart AAM. Canine mammary cancer. II. Therapy and causes of death. J Small Anim Pract 1979;20:395–404.
- Cohen D. Reif JS. Brodey RS, et al. Epidemiological analysis of the most prevalent sites and types of canine neoplasia observed in a veterinary hospital. Cancer Res. 1974;34:2839–2868.

 Johnston SD, Root Kustiritz MV. Olson PN. Discreters of the manufacty glands of the bitter. In: Johnston SD. Page Verwiter.
- mammary glands of the bitch. In: Johnston 5D, Root Kustritz MV, Olson PN, eds. Canine and feline theriogenology. Philadel phia: WB Saunders Co. 2001;246–253.
- Soreumo K. Canme mammary gland tumors. Vet Clin North Am Small Anim Pract 2003;33:573-596.
- Misdorp W. Canine mammary tumours: protective effect of fate ovariectomy and stimulating effect of progestins. Vet Q 1988:10:26-31.
- Dorn CR, Taylor DON, Schneider R, et al. Survey of animal neoplasms in Alameda and Contra Costa countres, California, H. Cancer morbidity in dogs and cats from Alameda county. J Natl Cancer list 1968;40:307–318. Schneider R. Doin CR, Taylor DON. Factors influencing canine
- mammary cancer development and postsurgical survival. J Natl
- Camer Inst 1069;43:1240-1261.
 Verstegen J. Onelin K. Etiopathogeny, classification and prognosis of mammary tumors in the canine and feline species, in Proceedings, Annu Conf Soc Theriogenol 2003;230-238.
 Donnay I, Rauis J, Devleeshouwer N, et al. Comparison of estrogened
- gen and progesterone receptor expression in normal and tumor
- mammary tissues from dogs. Am J Vet Res 1995;56:1188–1194. Hamilton JM, Else RW, Forshaw P. Oestrogen receptors in canine manimary tumouts. Vet Rec 1977;101:258-260.
 Bell FW, Klausner JS, Hayden DW, et al. Clinical and patho-
- logic features of prostatic adenocarcinoma in sexually intact and castrated dogs: 31 cases (1970–1987). J Am Vei Med Assoc 1991:199:1623-1630.
- Weaver AD. Fifteen cases of prostatic carcinoma in the dog. Vet Rec 1981;109:71-75.
- Teske E, Naan EC, VanDijk EM, et al. Canine prostate carcinoma: epidemiological evidence of an increased risk in castrated dogs. Mol Cell Endocrinol 2002;197;251–255.
- Soremno KU. Goldschmidt M. Shofer I; et al. Immunohisto chemical characterization of canine prostatic carcinoma and correlation with castration status and castration time. Vet Comp Oncol 2003;1:48-56
- Obradovich J, Walshaw R, Gouffand F. The influence of castra

- tion on the development of prostatic carcinoma in the dog: 43 cases (1978–1985). J Vet Intern Med 1987:1:183–187
- Leav I, Ling GV. Adenocarcinoma of the canine prostate gland.
- Cancer 1968;22:1329–1345.

 Durham SK, Dietze AE. Prostatic adenocarcinoma with and without metastases to bone in dogs. J Am Vet Med Assoc 1986; 188:1432-1436.
- Lipowitz AJ, Schwaitz AS, Wilson GP. Testicular neoplasms and concomitant clinical changes in the dog. *J Am Vet Med Assoc* 1973; 103:1304–1368.
- Johnston SD, Root Kustritz MV, Olson PN. Testicular neoplasia. In: Johnston SD. Root Kustritz MV. Olson PN, eds. Campe and feline theriogenology. Philadelphia: WB Saunders Co., 2001;324–
- Cotchin E. Neoplasia in the dog. Vet Rec 1954;66:879–888. Brodley RS. Canine and feline neoplasia. Adv Vet Set Comp Med 1970;14:309-354.
- Johnston SD, Root Kustritz MV, Olson PN, Ovarian neoplasia. In: Johnston SD, Root Kustritz MV, Olson PN, eds. Canine and feline therrogenology. Philadelphia: WB Saunders Co., 2001;200-203, 459-461
- Johnston SD, Root Kustritz MV, Olson PN, Uterine neoplasia. In: Johnston SD, Root Kustritz MV, Olson PN, eds. Canne and feline theriogenology. Philadelphia: WB Saunders Co. 2001;221. 470.
- Knapp DW, Glickman NW, DeNicola DB, et al. Naturally occur ring canine transitional cell carcinoma of the urinary bladder. Urol Oncol 2000;5:47-59.
- Norris AM, Laing EJ, Valli VEO, et al. Camne bladder and urethral tumors: a retrospective study of 115 cases (1980–1985). J Vet Intern Med 1992;6:145–153.
- Osborne CA, Low DG, Perman V, et al. Neoplasms of the canine and leline urinary bladder: incidence, etiologic factors, occurrence and pathologic features. Am J Vet Res 1968:29:2041 2055.
- farvin G. Patnaik A, Greene R. Primary urethral timors in dogs. Am Vet Med Assoc 1978:172:931-933.
- Poirier VJ. Forrest LJ, Adams WM, et al. Piroxicam, mitoxantransitional cell carcinoma of the bladder in 10 dogs: a pilot study. J Am Anim Hosp Assoc 2004;40:131–136.

 Henry CJ. Management of the transitional cell carcinoma. Vet
- Clin North Am Small Anim Pract 2003;33:597-613.
- Ru G, Terracini B, Glickman LT, et al. Related risk factors for canine osteosarcoma. Vel J 1998;150:31–39. Cooley DM, Beranek BC, Schlittler DL, et al. Endogenous go-
- nadal hormone exposure and bone sarcoma risk. Canc Epidemiol Biomark Prev 2002;11:1434–1440.
- Chun R. DeLorimier L-P. Update on the biology and management of caume osteosarcoma. Vet Clin North Am Small Anim
- Pract 2003;33:491-516.
 Colhard I., Ancel J., Benet JJ., et al. Risk factors for obesity in
- dogs in France. J Nutr 2006;136:19515–19545.
 Priester WA, McKay FW. The occurrence of tumors in domestic animals. Nutl Cancer Inst Manage 1980;54,169. 95
- Ware WA, Hopper DL. Cardiac tumors in dogs: 1982–1995. J Vet Intern Med 1999;13:95–103. 96.
- Smith AN. Hemangiosarcoma in dogs and cats. Vet Clin North Am Small Anim Praet 2003;33:533–552
- Prymak C. McKee LJ, Goldschmidt MH, et al. Epidemiologic, clinical, pathologic, and prognostic characteristics of splenic hemangiosarcoma and splenic hematoma in dogs: 217 cases (1985). J Am Vet Med Assoc 1988;193:706–712. Shen V. Dempster DW, Buchman R. et al. Lack of changes in
- histomorphometric, bone mass, and biochemical parameters in ovariohysterectomized dogs. *Bone* 1992;13:311–316.
- Ekici H, Sontas BH. Toydemir TSF, et al. The effect of prepu-bertal ovariohysterectomy on spine 1 mineral density and mineral content in pupples: a preliminary study. Res Vet Sci 2007;82:105-109.
- 101. Johnston SD, Root Kustritz MV, Olson PN. Prevention and termination of carmie pregnancy. In: Johnston SD, Root Kustritz MV Olson PN, eds. Canine and feline theriogenology. Philadel-phia: WB Saunders Co. 2001;172.

- 102. Salmeri KR, Bloomberg MS, Scruggs SL, et al. Gonadectomy in immature dogs: effects on skeletal, physical and behavioral development. J Am Vet Med Assoc 1991;198;1193–1203.

 103. Crenshaw WE, Carter CN, Should dogs in animal shelters be neutered early? Vet Med 1995;90:756–760.

 104. Root MV, Johnston SD, Olson PN. The effect of prepuberal and nostituberal consequences and applications.
- postpuberal gonadectomy on radial physical closure in male and lemale domestic cats. Vet Radiol Ultrasound 1997;38:42-
- May C, Bennett D, Downham DY, Delayed physical closure associated with castration in cats. J Small Anim Pract 1991; 32:326 328
- 100. Houlton JEE McGlennon NJ. Castration and physical closure in
- 100. Honflon JEE McGlennon NJ. Castranou and physical closure in the cat. Vet Rec 1992;131:466—467.
 107. McNicholas WT, Wilkens BF, Blevins WE, et al. Spontaneous femoral capital physical fractures in adult cats: 26 cases (1996—2001). J Am Vet Med Assoc 2002;221:1731—1730.
 108. Keller GG, Corley EA. Canine hip dysplasia: investigating the sex predilection and the frequency of unilateral CHD. Vet Med 1989;Tiec 1162–1166.
 109. Veeb DD, Cheng GE, March M.
- 109. Kealy RD, Olsson 5E, Monti KL, et al. Effects of limited food consumption on the incidence of hip dysplasia in growing dogs J Am Vet Med Assoc 1992;201:837–863.
- 110. Kancene JB, Mostosky UV, Padgett GA. Retrospective cohort study of changes in hip joint phenotype of dogs in the United States. J Am Vet Med Assoc 1997;211:1542–1544. Ledecky V, Seveik A. Puzder M, et al. Occurrence of hip joint
- dysplasia in some hanting breeds. *Vet Archiv* 2004;74:417–425.

 112. Priester WA, Mulvihill JJ. Canine hip dysplasia: relative risk
- by sex, size, and breed, and comparative aspects. J Am Vci Med Assoc 1972;160:735-739.
- 113. Arendt EA. Orthopaedic issues for active and athletic women. Clin Sports Med 1994;13:483-503.
- 114. Harasen G. Canine cranial cruciate ligament rupture in profile.
- Can Ver J 2003;44:845–846.

 115. Duval JM, Budsberg SC. Flo GL, et al. Breed, sex, and body weight as risk factors for rupture of the cranial cruciate figament in young dogs. J Am Vet Med Assoc 1999:215:811-814. Whitehair JG, Vasseur PB, Willits NH. Epidemiology of cra-
- nial cruciate ligament rupture in dogs. J Am Vet Med Assoc 1993;203:1016–1019.
- Slauterbeck JR, Pankratz K, Xu KT, et al. Canine ovariohyster ectomy and orchiectomy increases the prevalence of ACL injury.
- Chn Orthop 2004,429:301-305, 118. Wilke VL, Conzemius MG, Kinghorn BP, et al. Inheritance of rupture of the cranial cruciate ligament in Newfoundlands. $J\,Am$ Vet Med Assoc 2000;228:61-64.
- 119. Mason E. Obesity in pet dogs. Vet Rec 1970;86:612-616.
 120. Edney ATB, Smith PM. Study of obesity in dogs visiting veterinary practices in the United Kingdom. Vet Rec 1980;118:391-390
- 121. Sloth C. Practical management of obesity in dogs and cats. J Small Anim Pract 1992;33:178–182.
 122. Crane Sw. Occurrence and management of obesity in companion animals. J Small Anim Pract 1991;32:275–282.
- Flynn MF, Hardie FM. Armstrong PJ. Effect of ovariohysterectomy on maintenance energy requirement in cats. f Am Vet Med. Assoc 1996;209:1572–1581.
- 124. Martin LJM, Siliait B, Dumon HJW, et al. Spontaneous hormonal variations in male cats following gonadectomy. J Feline Med Surg 2006;8:309–314.
 125. Fettman MJ, Stanton CA, Banks LL, et al. Effects of neutering on
- body weight, metabolic rate and glucose tolerance of domestic cats. Res Vet Sci 1997;62:131–136.

 126. Root MV, Johnston SD. Olson PN. Effect of prepuberal and post-
- puberal gonadectomy on heat production measured by indirect calorimetry in male and female domestic cats. Am I Vet Res 1996:57:371-374.
- 127. Nguyen PG, Dumon HJ, Siliant BS, et al. Effects of dietary fat and energy on body weight and composition after gonadectomy in cars. Am J Vet. Res 200/E/05:1708–1713.
- 128. British Small Animal Veterinary Association. Sequelae of bitch sterilisation: regional survey. Vet Rev. 1975;96: 371–372.
- 129. Houpt KA, Coren B. Hmtz HF, et al. Effect of sex and reproduc-

- tive status on sucrose preference, food intake, and body weight
- of dogs. J Am Vet Med Assoc 1979;174:1083–1085.
 Robertson ID. The association of exercise, diet and other factors with owner perceived obesity in privately owned dogs from menopolitan Perth, WA. *Prev Vet Med* 2003.58.75–83. Seguin MA, Vaden SL, Altier C, et al. Persistent urinary tract in-
- tections and reinfections in 100 dogs (1989–1999). J Vet Intern Med 2003(17:022–631.
- 132. Root MV, Johnston SD, Johnston GR, et al. The effect of prepuberal and postpuberal gonadectomy on penile extrusion and methral diameter in the domestic cat. Vel Radiol Ultrasound
- 1996;37:363–366.

 Herron MA. A potential consequence of prepuberal feline castration. Feline Pract 1971;1:17–19.
- Senior D. Lower inmary fract disease—feline, in *Proceedings*. World Small Anim Vet Assoc Cong 2006. Available at: www.vm.comproceedings/Proceedings.phx7CID=WSAVA 2006& PtD=16
- 089&70=Generic. Accessed Jun 2, 2007.

 135. Herron MA. The effect of prepubertal castration on the penile urethra of the cat. J Am Vet Med Assoc 1972;160:208-211

 136. Lekcharoensuk C., Osborne CA, Lulich JP. Epidemiologic study of the Lower for human for
- of risk factors for lower urinary tract diseases in cats. J Am Vet Med Assoc 2001;218:1429–1435.
- Holt PE. Urinary incontinence in the male and lemale dog or does sex matter? Available at: www.vin.com. Accessed Oct 1,
- 138. Angioletti A, Del rancesco I, Vergottim M, et al. Urmary incontinence after spaying in the bitch: incidence and oestrogen therapy. Vet Res Commun 2004;28(suppl 1):153-155.

 Stocklin-Gautschi NM, Hassig M. Reichler IM, et al. The re-
- 130. Stocklin-Gautschi NM, Hassig M, Reichler IM, et al. The relationship of urmary incontinence to early spaying in bitches. J Reprod Fertil 2001;(suppl 57):233–236.
 140. Arnold S. Urinary incontinence in castrated bitches. Part I. Significance, clinical aspects and etiopathogenesis. Schweiz Arch ticheillal 1997;139:271–276.
 141. Thrusfield MV, Holt PE, Murrhead RH. Acquired urmary incontinence in bitches: its incidence and relationship to neutering practices. J Small Anim Pract 1998;39:559–566.
 142. Holt PE, Thrusfield MV, Association in bitches between breed, size, neutering and docking, and acquired urmary incontinence.
- size, neutering and docking, and acquired urinary incontinence due to incompetence of the tirethral sphincter mechanism. *Vet Rev.* 1993;133:177–180.
- Gregory SP, Parkinson TJ, Holt PE. Urethral conformation and position in relation to urmary incontinence in the bitch. Vet Rec 1992;131:167-170.
- Gregory SP, Holt PF. Parkinson TJ, et al. Vaginal position and length in the bitch: relationship to spaying and urinary incontinence. J Small Anim Pract 1999;40:180–184.
- Atalan G. Holt PE, Barr FJ. Ultrasonographic assessment of bladder neck mobility in continent bitches and buches with urinary incontinence attributable to methral sphinclet mechanism
- nary inconfinence attributable to brethrat spinnels inechanism incompetence. Am J Vet Res 1998;59:673–679.

 146. Beijerink NJ. Buijtels JJCWM, Okkens AC, et al. Basal and GriRH included secretion of F5H and FH in anestrous versus ovariectomized bitches. Therogenology 2007;67:1039–1045.

 147. Reichler IM, Pfeiffer E, Piche CA, et al. Changes in plasma consideration constitutions and method closure possessus in
- gonadotropin concentrations and wethral closure pressure in the bitch during the 12 months following ovariectomy. Therro-
- genology 2004;62:1301–1402.

 148. Reichler IM, Hung E, Jochle W, et al. FSH and LH plasma levels in bitches with differences in risk for urinary incontinence. The
- riogenology 2005;63:2164–2180. Reichler IM, Hubler M. Jochle W. et al. The effect of GnRH analogs on urinary incontinence after ablation of the ovaries in
- dogs. Theriogenology 2003;60:1207–1216.

 150. Reichler IM, Welle M, Sattler U, et al. Comparative quantitative assessment of GuRH and I H receptor mRNA expression in the urmary tract of sexually intact and spayed female dogs. Therro-genilogy 2007;1734-1142.
- Rosenthal KL, Peterson ME, Quesenberry KE, et al. Hyperad-nethocorticism associated with adrenocortical tumor or nodular hyperplasia of the adrenal gland in ferrets: 50 cases (1987– 1991). J Am Vet Med Assoc 1993;203:271–275.
- 152. Sheemaker NJ, Schuurmans M, Moorman II, et al. Correlation

- between age at neutering and age at onset of hyperadrenocotticism in lerrets. J Am Vet Med Assoc 2000;216:195–197.
- 153. Olson PN. Early spay and neuter, in Proceedings. North Am Vet Conf 1997;25.
- 154. Johnson-Delaney CA. Ferret adrenal disease: 2000 perspective.
- 154. Johnson-Delaney CA. Ferret adrenal disease: 2000 perspective. Exotic DVM 2005(8:31-34.
 155. Pabon JE, Li X. Lei ZM, et al. Novel presence of luternising hormone/chorionic gonadotropin receptors in human adrenal glands. J Clin Endocrinol Metab 1996;81:2307-2400.
 156. Schoemaker NJ, Teerds KJ, Mol JA, et al. The role of luternizing hormone in the pathogenesis of hyperadrenocorticism in neutered ferrets. Mol Cell Endocrinol 2002;197:117-125.
 157. Folkinds & Incidence of mounteria in colony raised Bearle does.
- 157. Fukuda S. Incidence of pyonietra in colony raised Beagle dogs.
 Exp Anim 2001;50:325–329.
 158. Egenvall A. Hagman R. Bonnett BN, et al. Breed risk of pyonietra
- in insured dogs in Sweden. J Vet Intern Med 2001;15:530–538. 159. Niskanen M. Thursfield MV. Associations between age, parity hormonal therapy and breed, and pyometra in Finnish dogs. Vet Rec 1998;143:193–198
- 160. Potter K, Hancock DH, Gallina AM. Chinical and pathologic fea tures of endometrial hyperplasia, pyometra, and endometritis in cats. 79 cases (1980–1985). J Am Vet Med Assoc 1991,198,1427–
- 161. Johnston SD, Root Kustritz MV, Olson PN. Disorders of the ca-Johnston SP, Root Kustruz MV, Olson PN. Disorders of the camine uterus and uterine tubes (oviduets). In: Johnston SD, Root Kustritz MV, Olson PN, eds. Canine and Jelme theriogenology. Philadelphia: WB Saunders Co., 2001;216.
 Johnston SD, Root Kustritz MV, Olson PN. Disorders of the feline uterus and uterine tubes (oviduets). In: Johnston SD, Root Fustritz MV, Olson PN, eds. Carine and climbals.
- Kustritz MV, Olson PN, eds. Canine and feline theriogenology. Philadelphia: WB Saunders Co., 2001:408.
- 163. O'Shea JD. Studies on the earline prostate gland. I. Factors influencing its size and weight. J Comp Pathol 1962;72:321–331.
- energy its size and weight. J. Comp rained 1902, (2.321–321.)
 104. Zirkin BR, Strandberg JD. Quantitative changes in the morphology of the aging canine prostate. Ana Res. 1984; 208:207-214.
 165. Mackenzie AR, Half T, Lo M-C, et al. Influence of castration and sex hormones on size, histology and zine content of canine.
- prostate. J Urol 1963;80:864-874. Lowsch LA, Gerlach RF, Gillett NA, et al. Age-related changes in the prostate and testes of the Beagle dog. Vet Pathol 1990;27:347–353.
- Berry SJ. Strandberg JD. Saunders WJ, et al. Development of ca nine benign prostatic hyperplasia with age. Prostate 1986;9:363-
- 168. Dorlman M, Barsanti J. Diseases of the canine prostate gland. Compend Contin Educ Pract Vet 1995;17:791-810

- 169. Cowan LA, Barsanti JA. Crowell W. et al. Effects of castration on chronic bacterial prostatius in dogs. J Am Vet Med Assoc 1991;
- 170. Johnston SD, Root Kustritz MV, Olson PN. Disorders of the canine prostate. In: Johnston SD, Root Kustritz MV. Olson PN, eds. Canine and Jeline thereogenology. Philadelphia: WB Saun-
- ders Co. 2001:340. Hess RS, Kass PH, Ward CR. Breed distribution of dogs with diabetes mellitus admitted to a tertiary care facility. J Am Vet Med Assoc 2000;216:1414-1417.
- Marmor M, Willeberg P, Glickman I I, et al. Epizootiologic pat terns of diabetes mellitus in dogs. Am J Vet Res 1982;43:465-
- 173. McCann TM, Sumpson KE, Shaw DJ, et al. Feline diabetes mel-bitus in the UK: the prevalence within an insured car population and a questionnaire-based putative risk factor analysis. J Feline Add Strate 1997 (2019) 1997. Med Surg 2007;9:289=299
- 174. Prahl A, Guptill L, Glickman NW, et al. Time trends and risk facfors for diabetes mellitus in cats presented to vetermary teaching hospitals. J Feline Med Surg 2007;[F pub ahead of print]. doi:10.1016/j.jfms.2007.02.004.
- Rand JS, Bobbermien LM, Hendrikz JK, et al. Over representation of Burmese cats with diabetes mellitus. Aust Vet J 1997; 5:402-405
- 170. Panciera DL. Hypothyroidism in dogs: 66 cases (1987, 1992). J Am Vet Med Assoc 1994;204:761–767.
- Milne KL, Hayes HM. Epidemiological features of canne hypo-
- thyroidism. Cornell Vet 1981;713-3-14. 178. National Center for Health Statistics. Health, United States 2006 with charthook on trends in the health of Americans. Hyattsville,
- Md. National Center for Health Statistics, 2006;176.

 179. Moore GE, Burkman KD, Carter MN, et al. Causes of death of reasons for euthanasia in military working dogs: 927 cases
- of reasons for euthanasia in minitary working dogs. 921 cases (1993–1996). J Am Vet Med Assoc 2001;219:200–214.

 180. Bronson R1. Variation in age at death of dogs of different sexes and breeds. Am J Vet Res 1982;43:2057–2050.

 181. Michell AR. Longevity of British breeds of dog and its relation-
- ship with sex. size, cardiovascular variables and disease. Vet Rec 1999;145:625–629.
- Greer KA, Canterberry SC, Murphy KE. Statistical analysis regarding the effects of height and weight on life span of the domestic dog. Res Vet Sci 2007;82:208–214.
- Robertson OH. Prolongation of the life span of Kokanee salmon (Orcorhynchus nerka hennerly) by castration before beginning of gonad development. Proc Natl Acad Sci U S A 1901;47:009—

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Facsimile Cover Sheet

January 30,2008

To: Ed P. Reyes,.(213)485-8907, Wendy Greuel (213)680-7805, Dennis P. Zine (213) 485-8088, Tom LaBonge (213) 624-7810 Jack Weiss (213) 978-2250, Tony Cardenas (213) 847-0549, Richard Alarcon (213) 847-0707, Bernard Parks (213) 485-7683, Jan Perry (213) 473-5946, Herb J. Wesson, Jr. (213)485-9829, Bill Rosendahl (213) 473-6920, Grieg Smith (213)473-6925, Eric Garcette (213) 613-0819, Jose Huizar, (213) 847-0680, Janice Hahn (213) 626-5431, Mayor Villarigosa (213)978-0750, John White (213) 978-1079

From: Judith A. Brecka, Esq. (310) 314-7360

RE: opposition to council file #07-1212 mandatory spay/neuter & microchipping of dogs and cats

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January 31, 2008

January 31, 2008

The Honorable Los Angeles City Council Mayor Villaraigosa John White, Legislative Assistant

Dear Council members, Mayor Villaraigosa and Mr. White:

Re: Council File #07-1212 OPPOSITION
MANDATORY SPAY/NEUTER/MICROCHIPPING OF DOGS AND CATS

I am the legislative liaison for the Staffordshire Bull Club of America, an organization of approximately 300 members. We are an AKC delegate club and oppose ordinances which force law abiding dog owners to spay or neuter or microchip their dogs.

The people of California vigorously opposed AB1634 when it was presented in the State Assembly and State Senate. I believe that it is an insult to all of California's registered voters when animal rights activists attempt to pass similar measures City by City and County by County. Animal rights activists only seek to eliminate of pets and all animal use.

If Santa Cruz is any example of what occurs when broad scope mandatory pet sterilization is passed, this will be a terrible financial burden on the City of Los Angles. Since Sants Cruz enacted similar ordinances, their animal licensing compliance has declined and their Animal Control; budget has increased. Costs of enforcement escalated into millions of dollars.

I oppose the Los Angeles Ordinance for Mandatory Spay/ Neuter/Microchipping of Dogs and Cats because I believe that no government should mandate serious potentially life threatening surgical procedures namely the sterilization for either animals or human. I am attaching a copy of an article written by Margaret V. Root Kustritz DVM that appeared in the JAVMA in December 1, 2007 which addresses my concerns. Medical procedures performed on either humans or animals should never be mandated by any government.

Accordingly as a registered voter and a tax paying as the members our club are, I would respectfully ask that the ordinance be withdrawn or defeated. I ask that you vote NO on any ordinance that mandates that sterilization and amicro-chipping of any per dog or cat.

-Sincerely,

Judith A. Brecka

Palagrance Reserve

Determining the optimal age for gonadectomy of dogs and cats

Margaret V. Root Kushitz, DVM, 1910, DACI

Elective gonadectomy of dogs and cats, most continuous performed as an OHF of lemales and castration of males, is one of the most common veterinary procedures performed in the United States. The reising ly, dog owners and metabers of the veterinary profession throughout the world have questioned the optimal age for performance of these surgeness or whether they should even be performed as elective surgenes. The objective for the information reported here was to provide a review of the scientific evidence, which could be used by veterinarians to counsel clients appropriately on this issue.

Traditional Age at Gonadectomy

Contently, most veterinarians in the United States recommend that elective gonadectomy be performed in dogs and cars at 6 to 9 months of age. However, there does not appear to be any actuatility evidence to document that this is the optimal age. In fact, the age at which pers have traditionally been spayed and neutered has varied through the years and with reographic location in the early 1900s, OHE was performed at 3 to 6 months of age and castration as early as 4 weeks of age 2 Over time, the recommended age for elective gonadectomy of small annuals increased to 6 to 9 months of age. It has been hypothesized that this was the result of an increasing popularity of dogs and cats as pets as American currens found themselves with more disposable income, a subsequent desire by those per owners to creproduction control in their animals, and the intent of vetermar rans to provide the salest possible anesthesia and smgery for these new Tamily members. Despite great advances in anesthetic and surgical techniques and multiple studies that provide evidence for the safety of anesthesia and surgery in dogs and cars of younger iges, veteriourians in the United States still eling to the recommendation to perform gonadecromy at n to 9 months of age, with the added stipulation that buches and queens should be spayed before their fusi estras

In some parts of the world, elective gonadectomy is considered uncludal and is strongly discouraged or disallowed by professional veterinary associations? Elective gonadectomy is illegal in at least 1 country? In Larrick? published in Europe, elective gonadectomy

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ABBREVIATIONS

| OHE | Ovanobysterectomy |
|-------|---|
| TCC | Transitional cell carcinoma |
| CCL | Cranial cruciate ligament |
| FLUTD | Falme lower urinary tract disease |
| BPH | Bornigh prostatic hypertrophy-hyperplasia |
| | |

is decried as "the tool of despots and tyrants throughout history," and the author of that article claims that gonadecromized dogs are "cardine cunticles, condemned to live their lives in a physical and mental twilight." That author also questions how a profession that pubhely declares uself the guardian of animal welfare can, with impunity perform elective suggery on animals for human convenience."

Cultural and personal factors, including religious allification extruce background intended working life of the animal, turban or rural location of the household, and literacy scatus, also may be associated with the like lihood that an owner will request gunadectomy for a per 30 species and sex also play a role; in retrospective surveys, cuts are more likely to be spayed or custrated than dogs, and butches and queens are more likely to have undergone elective gonadecromy than stud dogs or formeats.

Surgical and mestheric techniques for elective gonadectomy in does and cars of various ages are provided in the viterinary hierarme bett The reported incidence of postoperative complications in 4,016 dogs and 1,459 cats after elective surgery was 6-1% and 2-6%, respecnively, with most of these considered minor problems, including inflammation as the mersion site and gastrointestinal tract upset 13 Complications were more common in dogs that underwent surgery when they were 2 years of age. (i) in a study (i) in which investigators evaluated complications in 142 dogs undergoing OHE performed by fourth-year veterinary students, incidence al intraoperative complications was 6.3% and incidence of postoperative complications was 14-2%. Again, most of these were minor, including self-resolving hemorrhage and inflammation at the meiston are and gastrointesimal tract upset. In that study to the high incidence of postoperative complications was associated with an menges in suggry time, which was in turn positively concluded with increasing body weight of the animal in Studies^{17,17} in which incidence of intraoperative and postoperative complications for elective gonadecromes performed at various ages was compared, the only compheation associated with age at time of surgery was an increased incidence of postoperative infectious disease in dogs undergoing elective gonidections when they were 12 weeks old. This may have been an artifact of the source from which dogs were recruited for the study.¹⁵

Societal Benefits of Elective Gonadectomy

The primary societal benchts of elective goinalectomy in dogs and cats are fewer animals refunquished to humane organizations and the fact that a specific animal's contribution to pet overpopulation is minimized. Milliple studies to have revealed that sexually intact dogs and cats are more likely to be refinquished to humane organizations than are those that are gonadecto mized. In only 1 study to was it reported that there was an increased percentage of gonadectomized animals among those relinquished to humane organizations, animals in that study were relinquished for behavioral teasons, and it was considered likely that they had been gonadectomized as a possible treatment for behavioral problems, but with no subsequent improvement after surgery.

Millions of dogs and caus are cuthamized at humane organizations annually in the United States, with tstimater of 5.4 to 9.1 million dogs and 5.7 to 9.5 million cars enthanized in 1990.723 Crude estimates of annual death rates in dogs and cats are 7.9% and 8.3%, respecrively. Statistics from humane organizations housring at least 100 animals/y, combined with these death rates, suggest that a 400,000 dogs and cats should be curhamized at humane organizations annually "Not all animals cuthanized at humane organizations are earliemuch because of overpopulation²⁰; however, the aforemenuoned study. indicates that > 2 million does and cuts were cuthonized at those shelters alone and substantiants the loss of animal life and stress to workers at lumane organizations associated with overpopulation of dogs and cars in the United States

Sexually intact animals adopted from humane orgun_ations may be returned or may reproduce, both of which would repopulate those shelters. In Estudy,6 30-4% of relinquished animals were from unwanted by ters. In a survey? of dog, and car-owning households in the United States, 56% of 154 cartine litters and 68% of 317 Jeline litters were implanted. There is a lack of knowledge about reproduction, among animal owners, the most common reason reported for the applanned canne litters was that the owner did not know the buch was in hear? Up to 57% of buch owners were unaware that bitches may cycle twice each year, up to 83% of car owners were unaware that queens are seasonally polyestions, and up to 61% of dog and car owners were not certain or truly believed that their per would be better if it had a finer before OHE was performed.^{325 to}

Owners that adopt animals from humane or gain atrons routinely sign a spay neuter contract. However, compliance with such contracts is typically a 00% 5th Up to 90% of veterinarians support mendatory gonadectomy of dogs and cars prior to adoption. If hew venues exist for educating veterinarians in early-age gonadecromy of dogs and cars, with most being self-raught. (2011) Enhanced training of veterinarians

aus in carly-age gonadecromy and pediatric anesthetic techniques, mandatory gonadecromy of dogs and cars prior to adoption, and increased education of dog and car owners about small animal reproductive physiology can only be at benefit in addressing these socieral issues.

Benefits and Detriments of Elective Gonadectomy for Behavioral Concerns

Sexually dimorphic behaviors are those most commonly displayed by I sex, with mounting and urme spraying is primary examples to Aggression may be a sexually dimorphic behavior. Most community, only those forms of aggression associated with the presence of ternales in estrus (aggression between temales or between males housed with those lemales) are considered sexually dimorphic. Gonadectomy and the subsequent decrease in goindal steroid hormones have been correlated with a decrease in sexually dimorphic behaviors terms. Likelihood that gonadectomy will impact sexually dimorphic behaviors is not correlated with duration of the problem behavior and may or may not be associated with prior sexual experience of the affected animal. God tennability of working dogs is not alicied by gonadestomy and does not vary with age of the dog at the true of conadectomy.

Sexual behavior of male cats makes them extremely undesirable, and often unsale, household prts. A decrease in sexually dimorphic behaviors after castration of male clusterin extrautly powerful hench of elective gonadectomy. Sexual behaviors of queens, buches, and stud dogs, although still possibly undesirable, are less commonly so severe as to make these animals unterable as household pers.

Nonsexually dimorphic behaviors are not typically affected by goundectomy. One large-scale study of dogs revealed a possible increase in noise phobias and decrease in separation anxiety and submissive urination associated with gonadectomy performed before the dogs were 5 months old.

An increase in reactivity toward humans with arange (uidantiliar) dogs and in aggression toward family members has been reported after O(H) of buches in several studies 10 %. The reason for this possible tendency has not been defined but may be attributable to a decrease in earogen and oxytoem concentrations, both of which may exert authanxiety effects in some spectics. This tendency also may be a breed-specific phenomenon.

Cognitive function may be altered by gonadecromy comparison of the progression of cognitive dystunction in sexually intact and characted male dogs revealed a slowing of progression in sexually intact males in Sample size was small in that study, with only 6 dogs in the sexually intact male group. Androgen deprivation has been associated with increased anyloid deposition in brain, of humans and codenie, and with decreased synapses in brains of rodenie, and nonlinnian primates." However, in a study in which investigators directly examined brain tiestic for DNA damage, a significantly greater percentage of neurons had extensive DNA damage in sexually inner Beigles than in castrated Beagles between 9 and 10% years of age.

Benefits and Detriments of Elective Gonadectomy for Various Conditions

Several conditions in dogs and cars can be impacted by elective gonadectomy, including neoplesia and orthopedic diseases. Knowledge of the benche, and definitions associated with elective gonadectomy enables vereinaring to provide the best coursel to chems and also to promote animal health.

Mammary gland neoplasms—Mammary gland neoplasms are the most common tumors of female dogs, with a reported incidence of 3.4%, and they are the third most common tumors of female cats, with a reported incidence of 2.5% if it Mammary gland neoplasms are the most common types of malignant tumors in dogs if Mean percentage of mammary gland tumors in temale dogs that are malignant is 50.9%. If the finite malignant cats, if 90% of mammary gland tumors are malignant in temale cats, if 90% of mammary gland tumors are malignant in standard Metastises are reported in up to 77% of dogs with mammary gland careanomas, with the lungs being the site of metastasis in 30.8% of affected dogs with a mammary gland tumor was diagnosed were cultimized at the time of diagnosis.

Increasing age and breed arc risk factors for development of mamirary gland neoplisms, with a meanage at diagnosis of approximately 10 years in dogs and cats. The Breeds reported to be at increased risk for developing mammary gland rumors include the Boxer, Britiany, Cocker Spaniel, Dachshund, English Setter, Linghish Springer Spaniel, German Shepheid Dog, Maltese, Miniature Poodle, Pointer, Toy Poodle, and Yorkshire Terrier. Cat breeds reported to be at increased risk of tumor development are the Japanese domestic breeds and Scanese (Table 1). Springer.

Maintenance of sexually intace states is a major risk befor for development of mammary gland tumors in dogs and cars bove. Overall, sexually muset dogs and cars have 7 times the risk of developing mammary gland neoplasms when they get older, compared with the risk for spayed dogs and cars. O compared with the incidence in sexually intact dogs, dogs spayed before their first estrus have a 0.5% risk, dogs spayed after 1 estrus have an 8.0% risk, and dogs spayed after 2 estrois cycles have a 26.0% risk of developing manuary gland incophisms when they get older to Flowever, per-

forming an OHE may even have a substantial sparing effect in older dogs, with a reduced but still evident reduction for manufacty gland neoplasms in dogs spayed as late as 9 years of age of

An exact cause-and-effect relationship between rextually minet status and managery gland neoplasta has not been defined. Europea and progesterone have direct and induced standardly effects on manufary gland ussue, and receptors for both hormones have been identified in normal and neoplastic manufary gland ustates "1. In 1 report," it was suggested that manufary gland neoplasms may be more likely to develop to buthes that had overt pseudopregnancy more than 3 times during their life, which would support the hypothesis that there is a hormonal effect or a direct effect of malignant mansformation of inetabolically active manufacy gland tostic.

Prostatic neoplasms-The reported meidence of modatic tumors in dogs to 0.2% to 0.6%, and prosranc neoplasies in dogs are almost always malignant adenocaremonas (1). There is neoplastic differentiafrom the tissues of ductal or utorhelial origin, which are audiogen independent ussues. A However, castrated dogs are at an increased risk for development of prostatic neoplastics, with the increase in risk ranging from 2.4 to 4.3 times that of sexually intact male dogs (Table 2) 100 Mean age of dogs at diagnosis is approximately 10 years, with slightly younger dogs having promatic adenocarentoma with melastases to bones (Com An exact cause and-effect relationship has not been defined, but it has been suggested? that deprivation of androgens does not act to initiate neoplasia, rather androgen deprivation permus progression of disease

Other types of tumors—Testicular tumors are the second most common rumor type in dogs, with a reported medicine of 0.9%," Mean age of dogs at diagnosts is approximately 10 years," *** Most tumors are readily diagnosed during physical inspection. Malignancy is considered low for all types of testicular tumors; therefore, castiation is currative.**

Ovarian and interine tumors are uncommon in dogs and cais. Although madign on tumors of both tissues have been reported, meassnass is rare and OHE is cruative in most situations ^{mag}.

Table 1 - 3 notice and darpnions of OHL for vacous conditions in terminable

| Condition | Incidence | Substantial mornidity? | Spacific broads at risk? |
|---------------------------|--|------------------------|--------------------------|
| Renefits | | | |
| Maximary gland neoplasms | 25% in all cats; greatly reduced when spayed bolora first esting | You | Yf:u" |
| Overtan or oferine tamors | low | No | No |
| Pyometra | Increases with ago | No | No |
| Dotriments | | | |
| Complications of surgery | 2.6% | Nο | Nο |
| Ομασιίγ | High | Nu | Nο |
| FINTO | 0.6% | Nu | Nu |
| Diaboto's multitus | 0 5% | No | YUET |

"Japanase domesuc broods and Statione - Diminase

Table 20-Bandits and datuments of grandestomy for whoms conductor, in male doas.

| Condition | Incidence | Substantial morbidity? | Specific breeds at risk? |
|--------------------------|--------------------------|------------------------|--------------------------|
| Banchts | | | |
| lesticular neonlesms | O D.W. | Nυ | Nο |
| BPH or proscattle | 75% 80% by Gyeats of ago | Nο | Nυ |
| Detronguts | | | |
| Complications of surgery | 6 0% | No | Nο |
| Prostatic neoglassis | 0.2% 0.6% | Yer | No |
| TCC | 1% | Nu | YLS. |
| Ostoosarcania | 0.2% | Yes | Yest |
| Hemonyiosarcoma | 0.2% | Yes | YI+5 L |
| CUL rupting | 1 B% | You. | Yesk |
| Obnsity | 2.8% | Na | Yesil |
| Diabetes melinus | 0.5% | No | Yes¶ |

^{*}Augdale Jerrier Bengle Collie, Scottish Terrier, Shriffind Sherodog, West Highland Where Terrier, and Wire Fox Terrier 3 Otherman Poeschut, Great Chine, Josh Serter, Irish Wolfhound, Nottweder and Saint Bornard, Thoser English Solter, Garnan Shaphard Dog. Golden Robiover, Great Dane, Lebrodor Retriever, Poulice, Poulie and Siborian Husky &Akita. American Staffordshire Terrior, Chesopeake Bay Retriever, Gorman Shepherd Dog. Golden Retriever, Labrador Retriever, Masalli, Neapolitan Masalli, Newfoundland, Prodle. and Saint Burnard. IlDengle, Corn Terror, Cavaller King Chorles Spaniel, Cocker Spaniel, Dachshund, Lubradur Betriever, IlAiredalo Torrici, Cocker Spaniel, Dachshund, Doberman Pinscher, Goldun Retriever, Irish Sutter Miniature Schneitzer, Poniuranian, and Shotland

The most common fillion of the genury tract of dogs is TCC of the bladder "sim Overall incidence of TCC in dogs is reported to be at most. Po of all malumant tomors in Breeds at increased risk for development of a ICC include the Airedale Terrier, Beagle Collie, Scottish Terrier, Shetland Sheepdog, West Highfand White Ferrier, and Wire Fox Terrier (Table 3) " Consideronized animals have a risk for development of 100 approximately 2 to 4 times that of sexually intact animals 2006. An exact cause and effect relationship has not been defined

Osteosarcoma is a highly malignant tumor, with a reposted incidence of 0.2% 88 Risk of development of osteosarcoma increases with age and may increase with increasing body weight "12" Breeds reported to be at increased risk for development of an osteosarcoma include the Dobennan Prescher, Great Dane, Irish Setter, Irish Wollhound, Rottweiler, and Saint Bernard." " In 1 study" at which historical data that consisted of owners assessments of hody condition score and body weight were used for analysis, incidence of ostensarcoma was not correlated with hody weight, flowever, owner assessment of body condition score is poorly correlated with vetermarian assessment of body condition score "11

Considertoniv can increase the risk of development of osteosarcoma by 1.3 to 2.0 mines "1" In 1 study" in which investigators evaluated 683 purebred Rottweilers, there was a significant merease in the meidence of osteosarcoma in female and male dogs that had no dergone genadectomy when it I year of age, however, the overall incidence of osteosaicoma in this population of dogs was much higher than that in the general population, which suggested a hereditary component Furthermore, life span of dogs did not differ (mean). SD life span of sexually infact and castrated male dogs wos 9.3 ± 2.5 years and 9.2 ± 2.5 years, respectively) or was noticeably increased (me in life span in sexu

ally infact and spayed lemale dogs was 7.5 + 2.4 years and 9.8 (2.4 years, respectively) in gonadectomized dogs "An exact cause-and effect relationship has not been defined

Hemangiosarcoma is the most common rardiac tumor in degs, with a reported meidence of 0.2%, "Breeds at mercased (is), for development of hemangiosarcomainclude the Boxer, English Setter, German Shipherd Doy, Golden Retriever, Great Dane, Labrador Retriever, Pointer, Poodle, and Siberian Husley, with large breeds (in general) at increased risk compared with the risk for small breeds? For both cardiac and splenic hemangiocarcoma, relative risk is increased for gonadecromized animals, with spayed females reportedly having 2.2 times. the risk of splenic beautigiosarcoma and 5 times the risk of cardiac hemangiosa compared with the risk for sexually musici foundes, and castrated males having 2.4 times the risk, compared with the risk for sexually intact males with An exact cause and effect relationship has not been defined

Orthopedic abnormalities--Postmenopausal womon or those who have undergone OHC have explicit concerus about osteopotosis. However, there is no decrease in initional density of bone in dogs after OHE. 99 in

timing of closure of the physics of long hones is controlled in part by gonadal hormones. In both dogs and cuts, gonadectomy at any age prior to physcal closure deliys that closure and is associated with statistically significant, although not readily visible or chinially relevant, lengthering of associated longbones convins However no specific correlation has been found between age at gonadecromy and incidence of long-hone fractures, including physical fractures. 5 In Estudy to there was an increase in the meidence of capital physical fractures in the femilies of castrated male cats, however, the eats with fractures were also overweight

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to become obese after ganadectomy, no correlation has been found between age at ganadectomy and final body weight or amount of body lar. ³⁴

Metabolic rate decreases after gonadectomy in cats 19,196. A cause and effect relationship between gonadectomy and obesity in dogs is less clearly defined. Spayed lemale dogs have an increase in food intake and increase in indiscriminate appetite after OHE, compared with those of shoin-operated or agr-matched control dogs 11,196. Estrogen may act as a safety factor, which would explain these changes 11. This does not address the correlation between obesity and enstration in male dogs. In both dogs and cats, obesity is not a mandatory consequence of gonadectomy, instead, it is controllable with an appropriate diet feeding regiment and exercise regiment.

Urinary tract disorders—spayed female dogs reportedly have an increased risk of developing urinary tract infections (2010). A cause-and-effect relationship has not been defined.

Lemale dogs spayed before onser of puberty may be more likely to maintain a juvenile or recessed vulva. In I study, to maintain a juvenile or recessed vulva, to I study, to bitches spayed at 7 weeks of ige had a vulva with a more immature appearance, compared with the vulva in bitches spayed at 7 months of age. It is the author's experience that bitches spayed as adults will have vulvar atrophy, which achieves the same result. A juvenile vulva in an otherwise healthy dog is of no clinical relevance. Overweight buches with a recessed vulva especially those with concurrent utinary incontinence are more likely to develop perivolvar demantis.

Male dogs costrated at 7 weeks of age had less periode development than did dogs costrated when they were older ¹⁰⁰ Male cats custrated before onser of puberty may have a decreased ability to extende the penis ^{100,00} Clinical relevance of this phenomenon is not known

Leline lower tiringry traci disease is a syndrome consisting of hematicia, dysuria or pollakturia, and possable irreflical obstruction and is most commonly classified as idiopathic. The reported incidence of FLUTD is 0.6%,100 Despite numerous vehemently declared anecdotes of an increase in the incidence of pretheat obstruction in male cars castrated when young, numerous studies? (1770) have failed to detect a correlation be tween gonadectomy of cats at any age and a decrease in diameter of the weethin or an increase in incidence of PLUID, with or without urethral obstruction. In 1 large study "" investigators identified gonadecromy as a risk factor for development of FLUID in both female and male cars and also identified an increased risk of development of LLUID in overweight or obese cars. In that study, sexually intact lemale cats bad a relatively reduced risk for development of 14 UTD

Urethral splinger mechanism incompetence, formerly known as estrogen-responsive primary in contineous, is a common problem of spayed lemale dogs between the condition is evident with equal frequency in ovariohysterectomized or ovarietomized female dogs, with the reported incidence ranging from 4.9% to 20.0% between Studies of his based to detect a correlation between age at time of OFHE and likelihood of developing incontinence. In a study of 985 female dogs, but hes were significantly less likely to develop

incontinetice when spayed at ~ 3 months of age. Other risk factors include body weight, with dogs weighing ~ 20 kg (44 lh) at increased risk; breed, with Boxers. Dobetinan Pinschers, Gaint Schnanzers, Irish Setters, Old English Sheepdogs, Rottsveilers, Springer Spaniels, and Weimeratters at increased risk and Labrador Retrieves in decreased risk in European studies and urethral length or testing position of the armary bladder the first and exacts ause and effect relationship has not been defined with research currently focusing on aheard gonadorropin secretion after gonadectomy ^{16 for} typically, ureilial sphincter mechanism incompetence is easily controlled with medical maximents.

Adrenal gland disease -- to the author's knowlrdge, there are no reports of an increase in the rocidence of adienal gland disease associated with sexually infact status in dogs and cars. In the United States, almost all leticts are gonadectomized when extremely young; the uncidence of advenal gland disease in terrets is higher in the United States than in European countries where ferrers are not routinely spayed or castrated to the In I study¹³⁴ in Parope, a correlation was detected between age at gonadecromy and age at onser of adrenal gland disease, with ferrets gonadectonized at a younger age having clinical signs of adienal gland disease earlier in life. Sexually much ferrors also have adrenal gland discase 11 Possible causes for this include lack of downregulation of sex steroids or an increase in circulating concentrations of gonadotropms that causes adrenal gland hyperplasm and possibly contributes to acoplas tic transformation 19109

Pyometra---Incidence of pyometra in dogs and cats in the United States has not been reported, perhaps because of the prevalence of OHL in these species before they reach an age when they would be likely to develop pyometra. In other countries, 15.2% and 23% to 24% of buches developed pyonictra by 4 and 10 years of age, respectively (with two metrics more common in multiparous buches flom in buches with a history of carrying a pregnancy successfully to term there is a siginficant likelihood that caes will have clinical evidence of merine disease when queens reach 5 years of age. 100 Dog breeds reported to be at mereased risk of developing pyometra include the Bernese Mountain Dog, Cavaher King Charles Spaniel, Chow Chow, Collie, English Cocker Spaniel, Colden Retriever, Rottweiler, and Saint Bernard factor to animals with pyonictia. OffE is curative, with reported mortality rates of 0% to 17% in dogs. and 8% in cuts ^{incom}

Nonneoplastic prostatic disease—Benigh prostatic hypertrophy-hyperplasta is a common disorder in sexually intact male dogs. In 1 study, his investigators evaluated male dogs. Of 300 sexually intact male dogs, 231 (65,4%) had IMTL all castrated male dogs in that study had protound prostatic atrophy. Development of BPH is positively correlated with age, half of all sexually linact dogs will have histologic or clinical evidence of BPH, with the incidence increasing to 75% to 80% by 6 years of age and 95% to 100% by 9 years of age and 95% to 100% by 9 years of age. Set to the BPH not prostative in addition, BPH predisposes dogs to prostative. We there BPH not prostative is commonly associated with substantial morbidity, and

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castration is an integral part of the treatment of both conditions for the

Endocrine disorders...The reported incidence of diabetes mellitus in dogs is 0.5% 117 Risk factors include breed, with Miniature Pondles, Miniature Schuldzers, Pugs, Samoyeds, and Joy Poodles at increased risk sex, with female dogs more commonly affected than male dogs; and increasing age 10000 for 1 study. O a possible increase in the risk of developing diabetes melhius was detected in castrated male dogs, however it was not defined whether the could have been as sociated with obesity in these animals. In cars, the reperiod incidence of diabetes mollitus is 0.4% and risk factors include breed, with Burmese cuts at increased risk, sex, with males at mercased risk; and increasing age 1701. Gonadectomized male and female cars have an increased risk, with gonadectomized cats having 8-7 times greater odds of developing diabetes mellitus thau for sexually infact cats 153 (5

The incidence of hypothyroidism in dogs is 0.2% to 0.3% (2017) A breed predisposition has been described for the Aircelale Terrier, Cocker Spaniel, Dachsbund, Doberman Pinscher, Golden Retriever, Jush Seiter, Miniature Schmauzer, Pomeraman, and Shethard Sheep dog breeds. (hit Hose studies have revealed in increased risk of development of hypothyroidism for spayed leniale and castrated male dogs, compared with the cisk for sexually intact dogs. A cause and effect re-Lumonship has not been defined. Hypothyroidism typically is easily controlled with medical treatment

Tale span - Life expectancy at birth for women in the United States is 80 d years, whereas that for men is 75.2 years the Results for dogs vary the mount with females living longer than males in some studies and the reverse being lound in other studies. Negative correlations have been detected between hody weight and longevity and between height and longevity in dogs, " Several studies" man have revealed an increase in longevity for gonadectomized animals when compared with that for sexually more animals In sockeye calmon, life span is significantly longer in fish cestrated before gonadal development, in Results of these studies argue against the evolutionary theory, which holds that it is not priident for a population to carry individuals that have aged past reproductive usefulness in In dogs and cats, this may be a reflection of enhanced care of animals by owners who have made the investment of surgery or a decrease in risk associated behaviors (such as roaming) in gonadectomized animals

Conclusions

How does a vetermanan reconcile all of these data to make the best possible recommendation regarding optimal age at which to neuter male and lengthe dogs and cars? The author provides the following assertions

Animals housed at humane societies should be treated as a population. Societal benefit resulting from gonadectomy of unowted dogs and cars in the United States ontweighs all other concerns Male and female dogs and cars should be spayed or castrated before being offered for adoption by humane organizations

- Pets should be considered individually, with the understanding that for these pets, population control is a less important concern than is health of each animal. Pops and cars should be maintained as household pels. Responsible owners should ensure that then pets are provided appropriate and regularly scheduled vererinary care.
- The behavior of most sexually intact male cats makes them undestrable or dangerous as pets. Because castration substantially reduces these sexually dimorphic behaviors, it is recommended that all male cars not intended for breeding be castrated prior to puberty and that all breeding males be castrated as soon as their use as a breeding male has ceased.
- For lemale cats and male and lemale dogs, veterinacians and owners must consider the bunches and detriments of gonadectomy for each animal (Tables 1-3) Pactors to be considered include incidence of various conditions associated with gonadectomy; degree of morbidity with substantial morbidity defined as a condition prevident in > 1% of the population, associated with 50% of the muligrancy or mortality rates, or not easily controlled by noninvasive treatments or good husbandry; breed; and in tended working or breeding life of each animal.

As an example, consider a discussion between a verermarian and the owner of an 8 week-old temule Labrador Retriever that is not intended for breeding. This dog would bench greatly from OHE before her first estrus as a means of preventing manimary gland fumors, which are extremely common and cause substantial morbidity (Table 3). Because of her breed, derriments of OHE melade an increased predisposition to CCI injury, hetmingiosaiconia, and obesity. However, there is a low incidence of hemangiosarcoma, and obecats can be readily controlled with good husbandry, which leaves CCA inputy as the most important possible detrinent. Because the incidence of C.C.I. rupture is lower than than of mammary gland neoplasia, a veternarian may choose to recommend OHE and educate the owner about minutenance of optimal body condition and other management techniques that will minimize potential for CCL inputy An OFFE should be performed before the dogs first estrus. To minimize the potential for development of armary incontinence, the vererinarian may choose to wait to perform the OHE until after the dog has reached 3 months of age.

The information provided here on the risks and det ronents of gonadecromy is not intended to promote or to numificathe importance of gonadectomy as a means of controlling annual populations or possible impacts on animal health or behavior of a specific animal. The vergringly profession recognizes the need for individual assessment of resk and benefit when evaluating vaccination protocols for animals. Plugidation of the genome in various species may lead to individualized diagnostic and treatment plans for each autinal in the future. It behooves us as veterinarians dedicated to the provision of the best possible one for animals to educate clients and evaluate each animal carefully when making recommendations regarding gonadectomy.

- Daniels R. Canno. Companiose for Independence. Deliware, Oldo Personal communication, 2002.
- b. Hahn RA, Worth their MA. Techov RL An epideomological continuous of 1202 dops with resticular neoplasta (abstr). The Intern. Med 1907 6 131.

References

- Greenfield CL Johnson AL Schoeller DJ Trequency of use of various procedures skills, and areas of knowledge among verer matrians to provide anall amond exclusive or predominant protises and profescincy expected of new vereinary school graduares. J Am Vet Med Assoc 2004;224:1780-1787.
- Sahmen KR, Olson PN, Bloomherr MS, Heethyr gonadectomy in dogs, a tyve w. Lon. Wt. Med Assoc 1991, 1981-1983, 1992.
- 3 Canzel-Apel AR Taily contains of dogs and cars from the point of view of month welfine. Pisch Trengel Workinsch. 1993 (1):305-298.
- To Colley (b) Sexual mutilation. Vet times 1998 Dec. 34
- 5. Fig. CA. Lee MC. Costration, other management practices and according to implications for dog loopers in Nsulder veaturing State. Stigmachtige Ver Med 2002, 35-25-1-200.
- 6 Morning AM Row in AN Companion amount demographic and readington states results from a newcy or logic Mass who serie towns. Author, pag. 1902;5:103–201.
- Maltlow JC. Uselin alon of the proportions of dogs and case for an surgically sterificed. J Am Vet Med Assoc 1900,213 gain, 647.
- Alexander SA, Shane SM, Cleuracterisms of animals adopted from an animal control center whose owners compiled with a quiytophic mering program. J Am Vet Med Assoc 1004, 205–476.
- 9 New Jee Salman MD, Scarlett JM, et al. Shelter relinquishment characteristics of shelter-relinquished animals and their own co-compared with minutes and their owners in DS per owning households. J Appl Anim Welf Sci 2000; 3 170–201.
- 10 Howe FM Surgical methods of contractition and sterilization. Hardingstology 2006;66:300–300.
- 11 Hove IAU Prepair and paradications in dogs and cags part I compand Contin Palia Pract Vet 1990;21 [ON 1] 1
- Howe EM. Prepulseral provide conve in dogs and cars pair 41. Compand Contin Udic Pract Vol. 1999;21:197-201.
- Follare CL, Romeir RN, Bamacy SC, et al. Prespoperative complications of elective surgeries in dogs and case determined by examining electroide and paper medical records. J Am Vir Med. Assoc 1990; 208-1882, -1886.
- 14 Furrow & Barchelor D. Copps, P. Complications observed dueing and after overady-spectrums of 112 bytches at a veteriously waching lossifial. Med Rev. 2005; 157(829):833.
- 15 Howe LM. Short term results and complications of prepulating gonadecromy to care and dogs. J Am WTM rd Assoc 1997, 211:57–67.
- 16 Howe FM, Shier MK Booth, HW, et al. Long-term ourcome of groundecromy performed an an early age or traditional age in care. J Am Net Med Assoc 2000, 217 1661–1663.
- 17 Howe LM, Slatia MR, Bondh, HW, et al. Lengtzem oriconic of goradications performed at an early age or traditional age in dogs. J Am Vet Med Assoc 2001;118:217–221.
- 18 Patronele G.J. Glickman I.J. Beck AM, et al. Pisk factors for in languishment of dogs to an animal shelter. J. Am Wit Med Associations, 200 572–581.
- Mondelli C. Piccole FR Verga M. et al. The fond that never developed adoption and relinquisbinent of dogs on a scar shifter LAppl Anim Welf Sci 2004.7, 23 3, 260
- Parenick G.F. Glickmen, C.F. Beck, AM, et al. 1814 Licture for relonguishment of cars to an animal whelter. J. Am Vet Med. Associ 1906, 200-582, 388.
- 21 Salman MD, Hurchlson J, Ruch Gallle R, et al. Behavioral ecaone for ichnopilstament of dogs and cats to 12 shelters. J Appl Annu Well Sci. 2000; 3-03, 100.
- 42 Jassa C Jaboy F Moulton C Annual shelter reporting study 1990 Unplewood Colo American Humane Assoc, 1902 5
- 23. National Coincid on Per Population Study and Policy National shelter censur, 1003 is rule from Collins, Cohe National Council on Per Population Study and Policy (100) 1, 2

- 24 New Je. Kelch WJ. Hutchison JM. et al. Durh and death rate estimates of cats and dogs in tPs hoped holds and related lucius. I Appl Anim Welf Sci 200 F 7 (20), 244
- 25 National Council to Per Population Study and Policy Sheller Statistic States (1994-1997). Available at www.perpopulation one Accessed (in) 2, 2007.
- 26 Kary PH, Naw R. Scarlett IM recal Enderstanding unusal companion surplus in the United States relinquishment of neuadoptable; to animal shelices for enthanish. J Appl Anim Welf Sci. 2001;4:237–240.
- Schiler JM, Schmin MD, New JG, et al. The role of vereining principalities of reducing dogrand car relinquishments and enthnousias. J Am Net Med Assoc 2002;220,306–311.
- Scarlett JM, Salman MD, New JC, et al. Reasons for relinquistiment of companion animals in US animal shelters, selected health and personal source. J Appl Anim Welf Sci. 1989, 5-41

 77.
- 20 Fig. M. Lekery S. Larly are spay/neutricle growing consensus Shelice Sing. 1993, Nov. 1.2
- 30 Spring CV Scarlett JM, Cully SM, Which to neutror dogs and ears a survey of New York state vereinninguis' procuces and helicls 1 Am Anim Hosp Assoc 2007, 38 482–488.
- Root Koistrotz MV Johnston SD. Fleberman FT. Availability of transling for proboral groundecromy at North American vegetiusty colleges. J Am Vet Med. Assoc. 2009. 216:1566–1567.
- 32 Harr PL, Lekstein RA. The role of gonadal hormones in the occurrence of objectionable behaviours in dops and cats. Appl. Ann. Behav. 5(1) 1007-12 (3) 33 (4)
- Stubbs WP, Idoomberg MS, Scrigge SE, et al. Effects of preprintental genuclei rong on physical and behavioral development in cars. John Vet Med. 4850, 1996-209 1864–1871.
- 2d. Spath CV Scarler [M. Heupt RA, Long-term risks and henelits of early age gonadections in ears. J. Am. Vet. Med. Associ-2001;224:372–379.
- Hopkus SC, Schobert JA, Hart BL, Castration of adult male dogs effects on toanium aggreemon immemarking and mounting J Am Vet Med Assoc 1976/108 (1994) 1340.
- Nielsen JC, J. Joseph RA, Hart BL. Effects of castration on problem behaviors in roalic dogs with releasing to age and diviation of 6th vine. J Am Vet Med Assoc 1997;211:180–182.
- 17 Hot 13 Bareti & Eller of casicaon on lighting roam ing and trunc spraying in adult male cats. J Am Vet Med Assoc 197 (16) 200-292.
- Hatt Bl.: Cooper F. Factors relating to urine quaying and fight ing in prepulserably grandectionized cars. J. Am. M. Med Associates 4 no. 12 65–12 pt.
- Rosenblao IS, Aranson LR. The decline of sexual helioción in male cars ofter e istration with special reference to the role of putor sexual experience. Echaero 1958;12:295–138.
- Feltorul B. Copulatory and aggressive lichavior in the prepulicitly castiated dog. Harm Behave 1970;1,127–136.
- 11 Sal (tall) [hpta A Com [alex-Convert, coal Hererosexual housing the cases the retroition of court-hip behavior following castration and elevate, membrale gapacity in limble high nucleichronide whiphad the fiels. Chembalophorus Juanuates, Horor Behav 200 (200 (200 (200)).
- 42 Root Kuster (MV) be two goods crony in the car Tehne Proce 1996 (4(6), 36, 30)
- Spain CV Scatlett JM, Houpe KA, Long-term risks and henclus of early upg remainer once to dogs. J Am Vet Med Associated 2019, 224–390. 63;
- Obstitell V. Ferchey E. Jathavinnial effects of oxonohysterections in hierarchy Small Army Press 1990;31:395-398.
- 45 Kim IIII. Yeon SC, Houpt KA, Graff Theors of oxyginlysurectors on on cactivity in German Shipherd Dogs. Vol. 2006;172:158-150.
- 16 Relsner W. Domonauch related augression of English Springer Spring by a review of SA cases. Appl Annu Behav Sci 1993, 37-83-83.
- 17 Mré aithe MM. McDonald LH. Brooks PI, et al. An anxiolytic action of environce, cohanecd by estrogen in the mome. Physical Relias 1997, 60 (1990) 1215.
- Herr III. (Herr of gonadecromy on subsequent development of age related cognitive imparament in dogs, J Am Vet Med Association 2001, 210–31. pp.

1672 Vet Med Today, Reference Point

JAMMA Vol.231, No. 11, December 1, 2007

- 10. Janox day polithe role of androgens in cognition and brain agrice the linear Neutroceano, 2006 | 38 1017 10 to
- Waters OJ, Shen S. Chelonau I. U. fafe expectancy antigonistic phonoreps and there as of dogs and men. Proceeding 2001,43,5372
- Tidler IJ Brodey RS. The biological behavior of emine main many neoplacines | Am Ver Med Assur 1967 131 1311.13116
- Versiogen I. Onelly K. Mammary rumos andu queco, in Proceedings Annu Coul Sor Thermpered 2003 239 247.
- 53 Dom CK Laylor DON True 11, et al. Survey of monal neoplasms in Alimeda and Contra Costa coundes. California, I. Methodology and description of cases I Natl Cancer Inst 1968 40.293 303
- More E. Population hased mentioned all manufacts tumors on some dog breedy I Reprod Ford Suppl 2001 57 (10) 443
- Robinslette. McNeil Pl. Thompson It et al. An epidemie logical analysis of a carmo biopose database compiled by a chargoon becopathology service tive Mr. Med 2001 of 125 1.16
- Confirm 1. Neoplasms in small animals, vir loc 1931.63/63/
- Prodev R5 Goldschmldt MH Roszel JR Canine mammary gland neophysis. J Am Aum Hosp A sec. 1983; 19 61, 90
- Monthon II Laylor DON Dorn CR, et al. Carona manufacture 120 more: Pathol Vet 1070 7 280..., 20.
- Things It Mealtup W. Immous and dysplastics of the minimus Pland Bull World Health Organ 1974, 30 111 . 13:
- Have HM, Millia RL Mandel CP (pulconological features of
- Teline manimacy cuchioma. Wit Rev. 1981;108e176-470. Mandford It: ResemblageLS, Coldman M. Manmary (timors of a 61 colour of Bengle dogs Ver Parlied 1986,23 741 759
- Methop Within MM Camb manning concer II. Therapy and consecret death I Small Amon Crack 1970 20 30, 101
- Cohen D. Reil Js. Brodey RS, et al. Epidemiological analysis of (1) the most prevident sites and types of cannic peoplasia observed in a colection y hospital Cancer Res 1971 of 1859 2866
- Johnston SD, Root Kusteriz MV Olson hN Disorders of the manimary plands of the blich, to Johnston SD, Roor Kirchetz MV. Ohon PN adv. Cantae and falling the ingenilogy. Philadelphla WB Sander Co. 2001 246 75 c
- Sciennio K. Camue mominary pland rumos. Vo Clin North Am Small Anim Pract 2003 33 573 596
- Modimp W Canne mannage tunious protective effect of line ovariecionis and crimularing effect of progressos. Vet Q 1988 10 26 31
- Doro t.K. Taylor DON, Schneider Rortal, Survey of animal neophysics in Alban da and Contra Costa countries California H. Cone comorbidity or dogs and case from Almordo comoly J Natl Cancer Ing. 1968cap 507-318
- Schmenler R. Doco CK. Taylor DON. Factors influencing carriemonutary confer development and postsings al survival. J Natl Concer fort 1969, 15 (2 p) 1261.
- (e) Verstegen I, Oneho K. Empatheyeny classification and proje noses of mammary tumers in the camine and teling species. In Peneralines Anna Cand Soc Oberingenial 2003/2-0-208
- Downay I Rame J. Devler-bouwer N. cral. Comparison of estrogen and provisicione receptor expression in normal and timen manufacts tissues from dogs. And Markes 1995, its 1186-1194-
- 71 Humlion IM. Else RW Lordany P. Oestrogen receptors in ca nine materials (dimetes, Verker, 1977, 101-258-260)
- Bell LW Remisner 18, Hayden DW et al. Chincal and patho logic features of prostatic adenocarcinoma in sexually infact and carried days 31 cases (1970-1987) JAM Art Med A Sur Tours ton 1052 Filliams
- Meaning AD Adictional cool prostator carrinonia in the dog. Ver Rection(1007) ...
- Teskert Naar LC VooDijk LM in tal Cardin prostan is arono. ma epidemiological evidence of an increased risk in caspated does. Met Cell Indoctinal 2002 107 Pat. 277
- Serenmo RU, Coldschmilli M. Sholo J, et al. himminolilyto chemical characterisation of caulite prosture correspond and correlation with castration status and castration com. Net Comp. Oncol 2003:1:48, 36
- 76 Obradovich I. Walshaw R. Goulland F. The collience of casua

- that on the development of prostatic curemonia in the dog. 1) co. cs. (1976–1983). J. Vel Julian Med. 1987; F183-187.
- Fe iv 1 Ling GV Adenovaicionoma of the cauthe prostate gland. Com o 1968/22/13/9/13/43
- Durham Sk. Durse Al. Prostant advocatements with and without inclusioner to bottom dags. J. Am Vet Med Assoc 1986, 188 1432 1435
- Esperanz Al. Schwarz, AS, Wilson Cd. Jestlenku neoplasms and concornion chapted changes in the dog 1 Am Mt Med Assoc 1973. 163 (364, 1369)
- Johnston SD. Root Kusuli. MV, Olson PN. Testiculai neoplasia In Johnston SD Jones Rusting MV Olson PM, eds. Canno and John the ray ralogy Philadelpher WB Sminders Co. 2001; 124.
- 24 Cerebuil Neoplasia by the dog. Wilker 1044-66-879-888
- Brodev RS Camp and John Grouplista Adv Vet See Comp Med 1000 14 200 144
- Johnston St. Roca Edistric MV Olson PN Ovneum neophista In Johnston 3D Root Knowle, MV, Obon PN, eds. Cambre and fellin the (togenology) I bilade lphia, WB Saunders Co. 2001, 2001. 203 4 20.461
- Johnston SD, Root Kustner MV, Olson PN, Oleone neoplasta In Johnston SD Root Kirstell, MV Olson PN vile Cannic and feline three genulogy. Philadelphia: WE Saunders Co. 2001;221.
- Knapp DW. Chelonan NW. De Ne da DR. et al. Naturally-occurring counce time stored cell conclusion and the industry bladder. Phil Oard 2000, ear 50.
- Notes AM Tame 11 Valle VEO, et al. Canno bladder and me HG thial formers, a reprospective endy of 115 cases (1080-1085). 1 See Intern Med 1000 (c 185-153)
- Osberto CA Low PG Permin Verial Neophisms of the canine and filme primary bladder invidence, enalogic factors or mission and pathologic learning. Am J McRes 1968(20-2041). 2(15)
- Lavor G. Paronic V. Coreire R. Pransay method rumors in dogs 1 Am 15 1 Med Accor 1978 17 20 (1 0 75)
- Poster VI. Fortest H. Adams AVM et al. Phosbant, mnoxin tione, and coarse button eatherberapy for the treatment of Constituent cell carenions of the blidder in 10 days a pilot 2004 JAM Antin Hosp A . or 2004 (10 131-136)
- Henry CL Management of the transformal cell categoria. We Clin North Am Small Anna Pener 2003 13:307-643
- Rio G. Jeroacial B. Glickman L.L. et al. Related visk factors for 91 cauling outcomic onal 377 J 1909, 156-31, 39
- Cooley DM Decarek BC, Schladia DL et al. Endogenous go midal becoming expecting and bone sancoura risk. Cane Epidemiol. Ramork Prev 2002 1 : 1131-1440
- Chan 9 (5) France (1-2) Epilate on the biology and manage ment of embic accessions. Vet Clin North Am Small Anim Pract 2003 V: 191 346
- Colload L. Ancel J. Penet H. et al. Risk between his obesity in doj : in Levico | [Nati 2006 | 156 19515 .19548.
- Priester MA McKay FW. The occurrence of tomors in domestic Junuals Nail Concer Ind Manage 1980 54 169.
- 96 Ware WA Tropper DE Cardiac ritmors in dogs: 1982-1995 [Wil Burrow Add I Vort 1 100 , 1815
- Smith AN. Hemangusarcom) in dogs and case Art Clbr North Am Small Anim Proce 2005; 12 3 13 352
- Prymale C. McKer I | Goldschmidt MH et al. I pidennologie, closed partiologic and prognostic characteristics of splente hemanejos, o coma and oplique be maioma in doge 217 cases (1083) JAM Vet Mad Assoc 1988 193 706-712
- Shen V Desopsies DW. Buchman R et al. Luck of Changes in historiorphometre, bone mass, and biochemical parameters in rosal diester cumpized dogs. Conc. 1907;13-311-316.
- 100 Place II, Some RIL bowlenin PSI, et al. The effect of preprihereal overtebysterectomy on spinic Cindineral density and infinitely content in puppies a probathary study Res Mr See 2007/62 105 100
- 101. Johnston SD. Root Rusting MV. Olson PN. Prevention and terminution of cating pregnancy in Johnston SD Jone Knight; MV Olson PN, eds. Canthe and feline the ingenology. Philadel. plea WB Samidor, Co. 2001-177.

- 10.2 Saling of KR. Bloomberg M5. Scrupps \$1. et al. Considerations In Immature dops: effects on sheleful physical and behavior if dese hipmin. J Am Ver Med Assoc 1991;198:1103–1203.
- 10.3 Crenshaw WI. Carter CN. Should dop: br animal shifters be occurred early. Art Med 1005 00 736, 760.
- 104 Root MV Johnston SV Olsen PN. The effect of prepublical and postpublical gonade tomy on tadial placeful closure on make and length domining us. Set Radial (dirasgund 1007, V3.42).
- 105 May C. Bennert D. Dovenham DV Delayed physical chooses associated with containing in care. J Small Annu. Cent. 1991, 32, C6, 329.
- 100 Honfton JCL McGlennon NJ. Castraffon and physical clientre in the car. Ver Rev. 1902 131, 106, 467.
- 107 McNicholas WT Wilkens Pf. Elevins WF or al. Spontaneous femotal capital physical fractures in adult cars. 26 cases (1906) 20013; J. Am Ver Med Assoc 2002;224–1731–1736.
- 108 Keller C.C. Corley LA. Canthe hip dysplacia: insectipating the SCS prediblemon and the frequency of undiperal CHD. Vet Med 1989 (Sec. 1162) 1106.
- 100) Kenly RD (Olsson M. Monti Kl., et al. Effects of limited food consumption on the incidence of hip dysplasty in growing dogs. J Am Vir Nucl. Assoc 1992;201:267–265.
- 110 Kancene II. Moersky J.V. Padrett GA. Retrospective colour study of changes in hip joint phenotype of days in the United States. J Am Vet Med Assoc 1997;211:1742–1744.
- 111 Indicky V Sevick A Pagder M et al Organiewe of hip jam dysplash ar some formuly breeds Westerberg 2004 14 417 425
- 112 Priester WA Mulvivill II. Caumo hip dooplista: relative risk by sec size and loced and comparative aspects. J Am Vol Med Assoc 1977, 160 733,730.
- 113 Arcide LA. Orthopaedic issues for active and arbitrac women of the Spaces Med 1004(13 383, 202).
- 114 Harrison C. Coming et mild et nerate ligenment ruponse la profile Can Vet J. 2003, 44, 845–8646.
- 115 Duval IM Budchery Sc. 1 for G1, et al. Duved, sex, and body weight according for cupture of the ceanial concare figurent in voting dogs. J Ana Net Med A sea, 1009, 215, 811–814.
- The Whitelmo Re Vescur PN Willia, NH Epidemiology of cratical effects them or reputite its dog. I doe tot Med Assoc [2013-963-1916, 1910]
- 115 Marticbeck B. Parkiatz E. Xu K.F. et al. Carrow overarrhystic ectomy and on bler convenience of the prevalence of Act Enjoy. Clin Oxthop 2004, 229–301, 305.
- 142 Willie VI. Conzentino Me. Kinghorn [9] et al. Inheritaire of reptime of the examic comptengament in Newfoundlands. J Am. Ver Med Assoc 2006-128 61, pd.
- 110 Mason I. Obesity in petidops. Vet Rev. 1970 86 612, 616
- 120 I direy ATE Smith PM. Study of obesity in dogs veiting vetermacy practices on the United Rongdom. Vet Rev 1986 118 (2): 396.
- 121 Sloth C. Practical management of objecty in days and cars. I Small Anna Proct 1902, 13,178–180.
- 172 Come SW. Occurrence and management of obesity in compartion annuals. J Small Anim Proof 1991, 33 275, 277.
- 123 Olyon MI, Dardo J M. Athermony P.J. Effect of evacuohysteric tomy normaliticinance energy requirement in care. J Am Vet Med. Assoc 1996, 209 1772, 173-1.
- 12.1 Martio FM, Sdam G Dumon FJW et al. Spontageous bosmon d variations in male cats following grounds from 311 chin. Med. Sing 2006/30 (2002) 313.
- 125 Lettinian MI Stanfort CA Bank, 11, coal fillion of neutring on body weight no rabidic kin and glucose relevance of dopositions. Cars. Res Vet Sci. 1907 62 131–136.
- 126 Boot MV Johnston SD. Olson PN. Effect of pre-publical and post-publical considerationy on heat production (magnest by inducer calculators) or male and brook domestic cits. Am J. Vet. Res. 1996;57:371–376.
- 127. Nguyên PG, Dumon HJ, Sdima JPS, et al. Olliers of alterny for and energy on body weight and composition after gonadectomy media. Am J 34 J Res. 2004;65: 1708–1713.
- 128 torte le Small Antinal Veterinary Association. Sequelic of buch stordisation regional survey Vet No. 1975/96/371-372
- 179 Houpe KA. Coren B. Hint; HI chall Ullect of sex and reproduc-

- the states in surpose palentine load make, and body weight of dogs. J. Am Ver Med Assoc 1079;174:1083–1085.
- 130 Robertson (I) The resociation of exercise, distand other the nors with a wno-species wed obesity in presidely owned dogs from metropolitin Perth. WA. Pres Ver Med 2003 58,7%,83
- 131 Segum MA, Viden SL, Altrei C, et al. Persistent urmary macinilicitions and reinfections in 100 days (1980–1999). J Vet Intern Med 2003 17 (27-53).
- 1.62 Root MV, Johnston SD, Johnston GR, et al. The effect of prepulseral and perapuberal genedections on people excusion and method distriction of domestic car. Vet Rullot Obrasonal, 1996, 37:363–366.
- 13) Hercor MA: A performal consequence of prepulsival lehm cassination tellus transport 1971 1975.
- 131 Soulor D. Lower minimum tract disease—leline in Proceedings World Small Amin vor Assocition; 2006. Available at www.vincont/proceedings/Proceedings-place(10)-WSAVA2006&PHD-16-080&Ct-Commer Accessed (iii) 2, 2007.
- 135 Derivo MA. The effect of prepuberral castration on the penile method of the cut. Joan Vet Med Assoc 1972 160 208-214
- 136 Jelichmornsol, C. Othorog, CA, John JP, Epideutiologic study of rolk lactors for lower utmany fract diseases in cars. J Am Vet Med Assoc 2001, 242 (1420), 1473.
- 1.17 Holi P. Ditouv to confinence in the male and Jemale dog or door sex new of Available it www.vai.com. Accessed Oct 1, 2009.
- 1.35 Angioletic V. Orlandersco J. Acegorium M., et al. Clauncy Incontinuous after speying or the buch Incidence and oestrogen theorpy. Vet Ves Common 2001;28(suppl.1):155-455.
- 139 Stocklin Gaussela NM. Hossig M. Reichler IM. Graf. The relationship of minory incontinence to early spaying in hitches. J Reprod Ferril 2001;6-inppl 271233-236.
- 140 Arnold's Orions in confinence in castilited bitches, Part I. Siputhemee, charest uspects and enopathogenesis. Schwerz Aich Orchested 1997, 130-771, 276.
- 141 Throsheld MV Bolt FF. Monthead KH. Acquired urmary incontinence in backet as orealesses and relationship to nemering practices. J Small Anna Prince 1998, 39:559-566.
- (1) Holt PT. Throsheld MV. Association in Intelies between threed size remering and decking and a quired termity incontinguaductor occumpations of the number splitterer incoharism. VI Res 1993;1 C 177-180.
- 14. Greensy Sf. Parkurson († 116). P. Perthial conformation and position in a bijou to accounty occuminance in the blich. Weeker 1992; Feb. 1765–176.
- 1.13 Gregory T. Holt Fr. Endouson TL or al. Vagoral position and length in the blich relationship to spaying and influory monthnence. J Small Anna Pract. 1990;40:180–184.
- 14) Aralan G. Holt Pl. Barr FJ. Oltrasonographic assessment of bladder neck mobility in continent but hes and buches with intunity incoming measurabilitable to medical splinicter mechanism incomprisince. Am J Vet Kes. 1998; 59: 673–679.
- 116 Benerink 31 Bornels [R WM, Oklous AC, et al. Basal and control induced secretion of PSII and 110 in ancistons versus oxalicationized linebes. The internaling 2007 67 1030, 1045.
- 11) Reachler INT Pholife 1. Piche CA et al. Changes in plasma provideragin concernations and medical cleane pressure in the lifeth during the 12 month. Joffowing avarietimy. The organilogy 2004 62 1301–1402.
- 1908 Reachdor IM Hung C. Jackbe W. et al. 1911 and 1,11 plasma levels, in buches with differences in risk for himary accounting tice. The integratory 2005;65:2464–2460.
- (40) Reichter IM (Indder M. Jachle W. et al. The effect of GuRH analogs on matery amountmence after ablation of the ovaries in dop. The ingenidacy 2003 on 1207, 1216.
- 150 Relettler IM, Welle M. Suttler D. et al. Comparative quantitative pressurement of enRIV, and CD receptor mRNA expression of the utimary tract of sexually linaer and spayed lemale dogs. Threlageodogy 2007 for 1474–1442.
- (3) Resembled (C. Peterson MI. Quesenberry K). Coal Physical respectively associated with absoluted immunity and the hyperplastic of the adventise plant in ferrors. 30 cases (1987) 1991). J. Am Vet Med Associated 2003;271–273.
- 132 Shoemaker NI Schommans M. Moorman Harral Correlation

- between age at neutering and age at one or of hyperadrenocord cosmodiction. J Am Ver Med Assoc 2000,216,103,107
- 153 Obsor PN 1 orly spay and neuter in Proceedings. Neith Am Ver Cond 1997 27
- 159 Johnson-Delmey CA. Ferret adienal disease. 2006 perspective Exone DVM 2006 B-31, 33.
- 155 Paleon H. Ja X. Lei ZM, et al. Novel presence of Internising bormonizehortonic genaderropin receptors or lumina adminal planel. In Internitocinal Metals (1006 81 2007) 2400.
- 136 Scheetbaker NJ, Joends KJ, Mol JA, et al. The cole of life outcop becomes on the pathogenesis of hyperediction outcome in neutered lengths, Mol Cell Endocraph, 2012, 197-147, 197.
- 157. Fukuda S. Imadema of pyrimetra in colons cused Beagle dogs. Exp. Anna 2001 50-325-329.
- 138 Tyenvall & Hagman R, Bonneri BN, et al. 150 ed (18k al. pveniera in insured doys in Sweden J Vertinien Med 2001;15(530) (3);
- 150 Niskunen M. Thursheld MV Associations between age parity borround therapy and breed and pyonictia of Lumsh does. Ver Rev. 1998;143-493, 498.
- 160 Porter K. Hancock PH. Gallina AM. Clinical and participate feature and endometrius in cases of cases (1980–1995). J Am Vet Med A. soc. 1991, 1985 (1931–1945).
- 161 Johnston SD, Roca Knerrlez MV Olson PN, Disordees of the earning of concentration of the congruence of the Control of t
- 16.3 Johnston SD, Roon Rusernz MV, Olson PN, Dworderseel the felung mering and mertine inher Goedocte). In Johnston SD, Roon Rusernz MV, Olson PN, eds. Cantine and Jelong thermogenology. Plotadelphya, WIV Sanoders Co., 2001–468.
- 163 OShica JD Studies on the comme prostate global 1.1 actors with current to Size and weight J Comp Pathol 1962 77, 321–331
- 164 Zirkin DR Strandberg ID. Quantitative changes in the morphology of the uping cantine promate. Anal Rev. 1984;206:207–214.
- 165 Mackenzie AR, Hall T. Lo M-C, et al. hillhieuce of castrallon and sex hormous on size, histology and zinc content of canne prostate. *J Phyl* 1063 89:864–874.
- 106 Lowerth LA, Gerlach RL, Gillert NA, et al. Ageoclated change of in the prostate and refres of the heaple dog. We traded 1900; 37:347–373.
- 167 Recry SE Steindlaug JD Saturder, AVI Clad Development of a function propose in chyperplas results are Product 1996, 6-5 A2.
- 168 Dorlinan M. Bresamo J. Decases of the contine prostate cland. Compand Conflict due Pract Viz 1905; 17:701–330.

- 169 Consult A. Barszont JA. Crowell W. et al. Effects of cartration on clumns. bacterial procupints in days. J Am Met Med Assac 1901, 100–146, 750.
- 170 Johnston SD, Root Riverrax MV, Olson FN. Disorders of the camuse prostate. In: Johnston SD, Root Kustritz MV, Olson FN cib. J. mon. and Jehne theragenology. Philadelphia. WB Saunders vo. 2001–140.
- 171 Hess RS, Kee PH Ward CR Breed distribution of dogs with deficies methods admitted to a terting core brighty. J Am Vet Med. Assoc 2000, 246–1414. 1417.
- 372 Marmor M. Widleberg P. Gheleman F.F. et al. Episcotrologic per 640 of diabetes inefficie in dogs. Am J. Vet Res. 1982, 13 465-470.
- 1) Mr.C. (no. 1 M.) an oson (Cl., Shaw D), cr. at J. Shire diabetes melbres with 1.k. the presidence within an insued cot population and a question nate based putative tisk factor analysis. J. P. Clin. Med Sing 2007;9:239–200.
- 179 Proht A Corputt C. Gickoon NW coal. Time needs indirisk for tors for diabetes a cilling. In cars presented to veryinary reach high hospitals. J. Februa Med Stov. 2007 [F-puls about of print]. doi:10.1016/j.j.jbbs. 2007.02.004.
- 173 Rand JS, Bolibertollon LM. Hendrikz JK, et al. Over representation of Ringuese outs with dishetts mellions. Aust Ver J. 1997, 73:302–403.
- 176 Paneter CDL Uppothyroidisor in dags, 66 cases (1987) 4002). J Am Gr Shift Ason. 1001 204 764 (187).
- For Millio KL, Thors TIM 1 pidemiological featings of couling hypothyrelating Council Viz. 1984, 74, 5-14.
- 479 National Center for Health Statistics. Health, United States 2006, with charitooli on terms in the health of Americans. Hyeteville Md. National Center for Health Statistics. 2006;176.
- 170 Monre Gl. Dinkman SD. Catter MN, et al. Causes of death or reasons for cub moda in inflicing winking dogs. 927 cases (1992) 1006; J Am Vet Med Assoc 2001 219 209-214.
- 1960 Broman RT Variation in are at death of dogs of different sexes and breeds. Am EVELR's 1992, 13: 2037–2039.
- 1901 Michell AR 1 ongewity of British breeds of dog and his relation-ship with sex. slace audiovascular variables and disease. Vet Rec. 1009, 147-625. 620.
- 183. Orientists. Camerbeats St. Minphy Rf. Substitutionallyses of guiding the effects of bright and weight on file span of the doments dog. Kos Vet Sci. 2007;32, 208-214.
- (B) Robertson CO. Probing thou of the ble span of Rokance salmon (One-above his marke knowle) by costrainin before beginning of gonal development. Proc Nail Acad Sci 11 S.A. 1961 (177):009-031.

.