

## **PRESENTATION SUMMARY & POWERPOINT**

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### **Risks and Benefits of Neutering and Early-Age Neutering in Dogs and Cats: Effects on Development, Obesity, and Select Orthopedic and Neoplastic Conditions**

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Neutering of dogs and cats confers a mix of benefits and adverse risks. The objective of this presentation is to highlight recent research findings on the associations between neutering (whether early-age or at a traditional age) and select medical conditions. In this abstract, the term neutering is used in the broadest sense to include both castration of male dogs and cats or ovariectomy (or ovariectomy) of female dogs and cats. The data on early-age neutering is from a retrospective cohort study of 1,579 cats and 1,659 dogs adopted from a large animal shelter between 1989 and 1998 (Spain, 2004).

**Obesity.** Several studies have indicated an increased prevalence of obesity in neutered dogs and cats. Energy consumption appears to decrease after neutering in dogs and cats, although the degree and timing varied between studies. Some researchers attribute neutering-related obesity in cats to increased food consumption and not to altered metabolic rate, suggesting that the weight gain can be prevented with a lower fat diet (German, 2006, Nguyen, 2004, Kanchuck, 2002). Obesity does not appear to be affected by age of neutering in cats, but among dogs, early-age neutering is associated with a lower incidence of obesity than neutering after 6 months of age (Spain, 2004).

**Canine Hip Dysplasia (CHD) and Cranial Cruciate Ligament (CCL) Injury.** One study found an increased incidence of CHD after neutering in boxers (van Hagen, 2005), and among dogs seen in an orthopedic surgical clinic, the prevalence of CCL injury among neutered dogs (4.7%) was more than twice that of intact dogs (2.3%) (Slauterbeck, 2004). These findings regarding CCL injury incidence are consistent with findings that the level of sex hormones affects the incidence of anterior cruciate ligament (ACL) rupture in humans. Hip dysplasia is increased among early-neutered dogs compared to those neutered after 6 months of age (Spain, 2004).

**Mammary Cancer and Prostatic Cancer.** Spaying before 1 year of age reduces the risk of mammary carcinoma approximately 90% in cats, and spaying before second estrus in dogs similarly reduces the risk by about 90% (Overley, 2005). The incidence of mammary cancers does not vary between ovariectomy (traditional spay with removal of the uterus and ovaries) and ovarioectomy (removal of just the ovaries) (van Goethem, 2006). Traditional thought is that neutering reduces the risk of prostatic cancer among male dogs. Recent research suggests that after neutering, however, changes in endothelin, a cell protein involved in cell growth, may eventually reverse the benefits of neutering on prostatic cancer risk (Padley, 2002) and the incidence of prostatic cancer may actually be higher in castrated dogs than intact dogs (Teske, 2002).

## Select References

### Early-age neutering

CV Spain, JM Scarlett, KA Houpt, 2004. Long-term risks and benefits of pediatric gonadectomy in cats. *Journal of the American Veterinary Medical Association*. 224(3): 372-379.

CV Spain, JM Scarlett, KA Houpt, 2004. Long-term risks and benefits of pediatric gonadectomy in dogs. *Journal of the American Veterinary Medical Association* . 224(3): 380-387.

CV Spain, JM Scarlett, SM Cully, 2002. When to neuter dogs and cats: a survey of New York state veterinarians' practices and beliefs. *Journal of the American Animal Hospital Association*, 38(4): 482-488.

### Physical development and obesity

M Hoenig, DC Ferguson, 2002. Effects of neutering on hormonal concentrations and energy requirements in male and female cats. *American Journal of Veterinary Research*. 63(5): 634-639.

AJ German. 2006. The growing problem of obesity in dogs and cats. *Journal of Nutrition*. 136: 1940S-1946S.

PG Nguyen, HJ Dumon, BS Siliart, et al. 2004. Effects of dietary fat and energy on body weight and composition after gonadectomy in cats. *American Journal of Veterinary Research*. 65(12):1708-1713.

ML Kanchuck, RC Backus, CC Calvert, et al., 2002. Neutering induces changes in food intake, body weight, plasma insulin and leptin concentrations in normal and lipoprotein lipase-deficient male cats. *Journal of Nutrition*. 132:1730S-1732S.

PD McGreevy, PC Thompson, C Pride, et al., 2005. Prevalence of obesity in dogs examined by Australian veterinary practices and the risk factors involved. *The Veterinary Record*. 156:695-702.

### Orthopedic disorders

JR Slaughterbeck, K Pankratz, KT Xu, et al. 2004. Canine ovariohysterectomy and orchiectomy increases the prevalence of ACL injury. *Clinical Orthopedics and Related Research*. 429: 301-305.

MAE van Hagen, BJ Ducro, J van den Broek, et al., 2005. Incidence, risk factors, and heritability estimates of hind limb lameness caused by hip dysplasia in a birth cohort of Boxers. *American Journal of Veterinary Research*. 66(2):307-312.

### Mammary and prostate cancer

RJ Padley, DB Dixon, JR Wu-Wong, 2002. Effects of castration on endothelin receptors. *Clinical Science*. 103(suppl. 48):442S-445S.

B Overley, FS Shofer, MH Goldschmidt, et al., 2005. Association between ovariohysterectomy and feline mammary cancer. *Journal of Veterinary Internal Medicine*. 19:560-563.

## Session I: Non-reproductive Effects of Spaying and Neutering

B van Goethem, A Schaefers-Okkens, J Kirpensteijn, 2006. Making a rational choice between ovariectomy and ovariohysterectomy in the dog: A discussion of the benefits of either technique. *Veterinary Surgery*. 35:136-143.

E Teske, EC Naan, EM van Dijk, et al., 2002. Canine prostate carcinoma: epidemiologic evidence of an increased risk in castrated dogs. *Molecular and Cellular Endocrinology*. 197:251-255.

## Session I: Non-reproductive Effects of Spaying and Neutering

Effects on Growth, Hip Dysplasia, Immunology and Tumors

By Dr. Vic Spain

### Risks and benefits of neutering and early-age neutering in dogs and cats

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Physical development

Select orthopedic conditions

Obesity

Diabetes

Select neoplastic conditions


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### Objectives

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 Highlight recent research findings on associations between neuter status (or time of neutering) and select medical conditions in dogs and cats

 Note: using *neuter* in the broadest sense

 Castration of male dogs and cats

 Ovariectomy (removal of just ovaries) or ovari hysterectomy of female dogs and cats

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### Limitations/Cautions

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- 🐾 Won't have time to address the quality, generalizability, and possible biases of every study cited
    - 🌿 If you will be using this information to shape neutering practices for a shelter or veterinary clinic...
      - 🐾 Review the original source articles
      - 🐾 Contact me or another veterinary epidemiologist
  - 🐾 Risks/benefits may be different for ovariectomy vs. ovariohysterectomy
  - 🐾 Risks/benefits may differ by age at neutering
  - 🐾 Any policy decision should consider the frequency and consequences of any condition
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### Long-Bone Development

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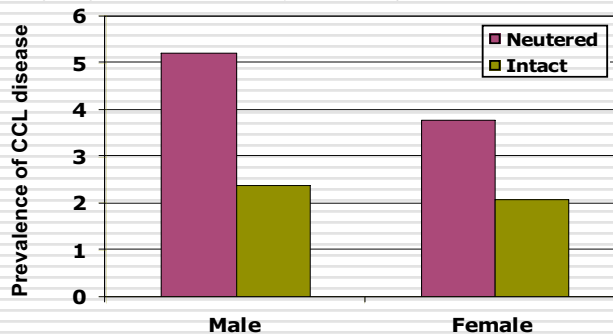
- 🐾 Dogs neutered at 7 weeks or 7 months of age had, on average, radial lengths 2 cm longer than those left intact (Salmeri, 1991)
    - 🌿 Pubertal sex hormones are part of the signal for growth plates to close
    - 🌿 With lower sex hormone levels, the bones continue to grow later into adolescence
  - 🐾 For cats (Stubbs, 1996), similar delay in growth plate closure with neutering, but not statistically significant difference in bone length
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## Does delayed physeal closure lead to more long-bone fractures?

- 🐾 Age of neutering not associated with frequency of long-bone fractures (dogs or cats)
  - 🐾 Animals neutered post-pubertally should be the same as those left intact (so wouldn't expect the neutered animals to be any lower risk)
- 🐾 Unaware of any study indicating an association between neutering and risk of long-bone fractures
- 🐾 Fairly low incidence of long-bone fractures in neutered dogs and cats in general
  - 🐾 Retrospective cohort study of 1,579 cats and 1,659 dogs adopted from a large animal shelter between 1989 and 1998 (Spain, 2004)
- 🐾 At this point, appears to be a mostly theoretical concern

## Cranial cruciate ligament (CCL) rupture in dogs

Prevalence of CCL (same as ACL in two-legged animals) rupture among dogs in one veterinary practice (Slauterbeck, et al., 2004)



- 3,218 dogs
- Single observer not blinded to neuter status at time of assessment



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### Mechanism for association between CCL rupture and neuter status?

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-  In humans, risk of ACL rupture associated with gender and among females, phase of the menstrual cycle
  -  Not associated with age of neutering (Spain et al., 2004)
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### Canine Hip Dysplasia (CHD)

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-  Difficult to tease out from recent literature
    -  Many studies of CHD focus on purebred dogs, many of whom are neutered only after they have been diagnosed with a potentially heritable problem
    -  Usually neuter status is not the main focus of these studies
  -  In a prospective cohort study of purebred boxers, neutering was associated with 50% increase in incidence of CHD (van Hagen, 2005)
    -  Did not present proportion neutered or assess reasons for neutering (i.e. Were these dogs neutered because they had poor conformation to begin with?)
  -  CHD increased with neutering before 6 months of age (Spain, 2004)
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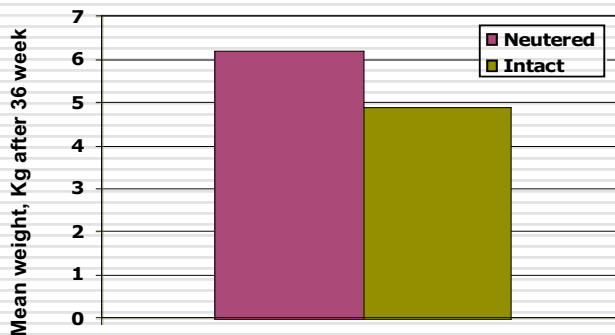
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### Risk of obesity increases with neutering in dogs and cats

- One recent example (Kanchuk, 2002)
- 16 normal adult cats in laboratory setting, 8 neutered, 8 intact
- Fed ad libitum



### Obesity (cont.)

- 🐱 Cats – Neutering appears to be associated with increased food consumption, but not necessarily lower metabolic rate (German et al., 2006)
  - 🌿 In laboratory setting, obesity can be prevented with lower-fat diet (Nguyen, 2004)
    - 🐱 Is education enough to counteract effect?
  - 🌿 Increased risk of diabetes, lameness, and certain skin conditions among obese cats (Scarlett, 1998)
- 🐶 Dogs – Neutering before 6 months of age associated with **lower** prevalence of obesity (20%) compared to neutering after 6 months of age (25%) (Spain, 2004)
  - 🌿 Does neutering early mitigate the increased risk of obesity associated with neutering in general?












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### Diabetes

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-  Dogs – Complicated mix of risk factors
    -  Different forms with different risk factors
    -  Certain breeds at higher risk
    -  Possibly secondary to certain endocrine disorders
    -  Intact bitches can have transient diabetes during pregnancy or diestrus
      -  Rarely requires treatment
    -  Not aware of any studies clearly indicating that neuter status alone is associated with risk of diabetes
  -  Cats
    -  More common among males
    -  More common among neutered cats
      -  May be a function of decreased activity and obesity, and not neuter status per se
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### Mammary Cancer (Carcinoma)

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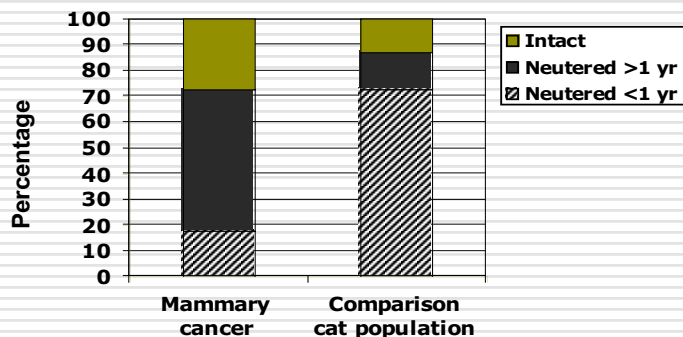
-  Historic studies in Alameda County, CA, showed strong protective effect of spaying dogs before second estrus (Schneider, 1969, 1975)
    -  Based on literature review, probably no difference between ovariectomy and ovariohysterectomy (van Goethem, 2006)
  -  Until recently, less clear in cats
    -  Overley et al. (2005) – Case/control study of 204 cases and 200 controls
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Neutering before 1 year of age lowers the risk of mammary cancer in cats (Overley, 2005)




Odds ratio for neutering before 1 year of age = 0.14

## Canine Prostatic Cancer (Carcinoma)

### Traditional thought

-  Neutering reduces testosterone levels, which should, in turn, reduce risk of prostatic cancer
-  Castration has been evaluated as a treatment in human cases

### Recent research indicates that after castration, human cases become insensitive to androgens over time

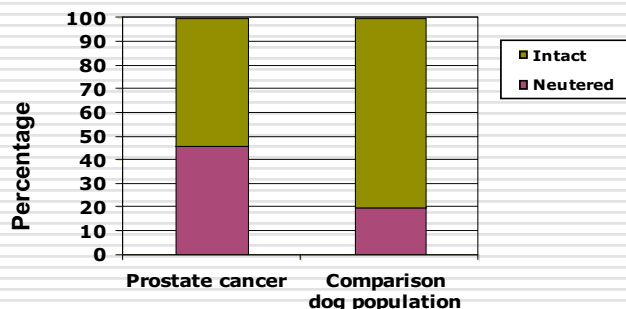
-  Endothelin binding increases after castration in dogs (N=6 dogs, Padley, 2002)

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### Castration associated with increased risk of prostate cancer (Teske, 2002 )



- Among 15,000 male dogs admitted to a teaching hospital in the Netherlands
- Odds ratio for neutering > 100 days before diagnosis = 2.3 – 4.3
- Probably much lower overall incidence in dogs than humans (0.4% of admissions)


### Immune status





- 🐾 Difficult to assess – How can we quantify the outcome?
  - 🐾 Decreased immune activity could lead to increased incidence of some infections but lower incidence of autoimmune or inflammatory disorders
- 🐾 Not aware of any studies clearly indicating an association between neuter status and overall immune function
  - 🐾 Neutering procedure may be associated with exposure to infectious agents at the time of the procedure (Howe, 2001)
- 🐾 Early-age neutering associated with decreased incidence of some inflammatory conditions in cats (Spain, 2004)
- 🐾 Early-age neutering **not** associated with incidence of repeated infections, demodicosis, or pyoderma in dogs (Spain, 2004)


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## Summary


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 Increased with neutering

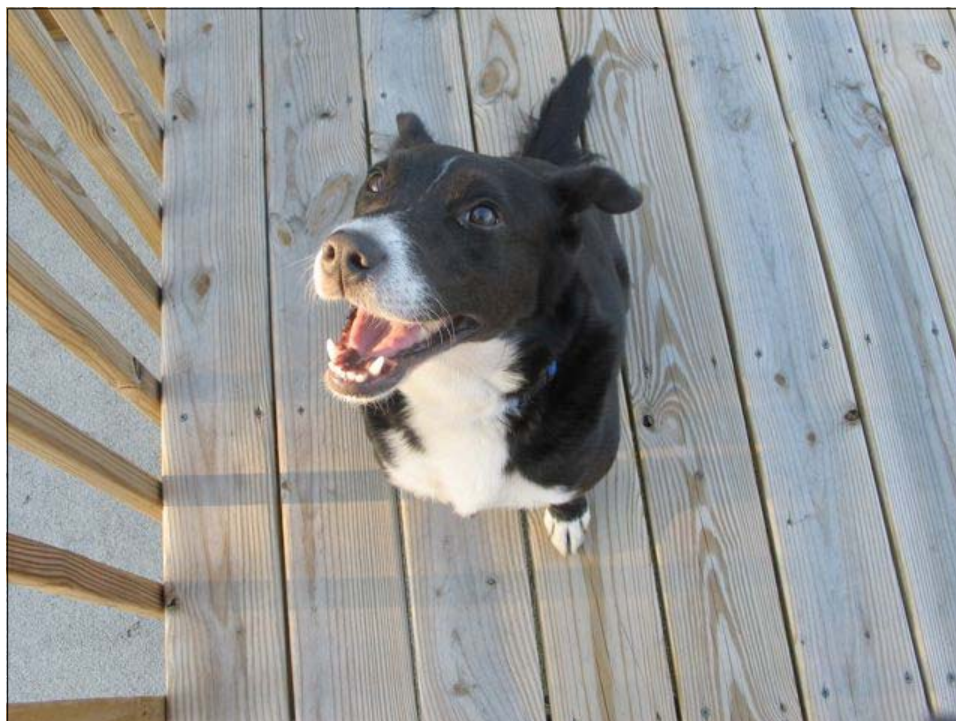
-  Obesity (preventable?)
-  CCL rupture (dogs)
-  Canine hip dysplasia?
-  Prostatic cancer (dogs)

 Decreased with neutering

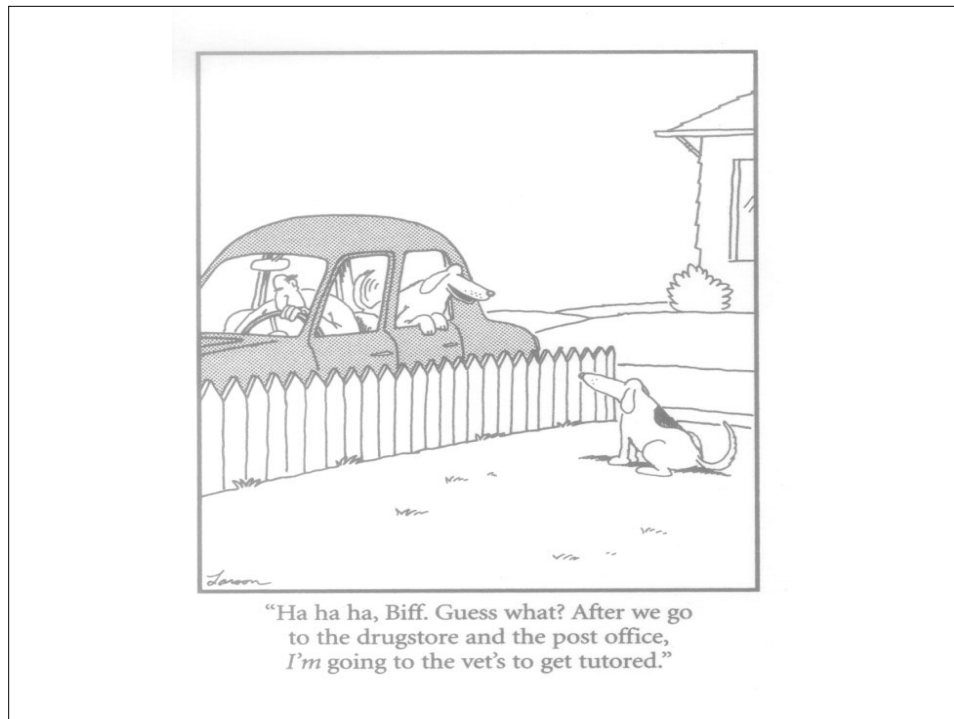
-  Mammary cancer

 Unrelated to neuter status (or lacking evidence)

-  Long-bone fractures
  -  Diabetes
  -  Immune status
- 



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## Acknowledgements

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