

Spay and Neuter: The Unintended Consequences



Dr. Suzanne M. Valente
June 1, 2023

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Executive Summary

Risk/benefit analysis has created a controversy with respect to spay and neuter. If you look at older studies (many of which are cited in this paper) you will see that many authors concluded spay or neuter had few risks - even if performed at an early age. However, in the more current studies cited, spay and neuter have been shown to increase the risk for orthopedic damage, behavioral issues, obesity, metabolic illness (e.g., diabetes, Cushings) and increased the incidence of many fatal cancers. Many of these studies were done at veterinary teaching institutions. Yet most veterinary teaching institutions, veterinary doctors and humane organizations continue to take the position that spay or neuter of a dog still confers significant health benefits and even extends lifespan. It is argued that spay and neuter continue to be good public policy despite potential harm to the individual dog.

In January of 2023, the American Veterinary Medical Association (AVMA) *finally* published the results of a study comparing the behavior, health and lifespan of dogs spayed or neutered to intact dogs or dogs sterilized by vasectomy or hysterectomy wherein their sex hormones are preserved. The study concludes that preserving sex hormones confers better health, behavior and a longer lifespan, whether the dog is intact or sterilized, as compared to dogs spayed or neutered (Zink, C et al. 2023).

We concluded over six years ago that the scientific literature and studies established spay and neuter as extremely harmful to each and every dog. The harm is so significant that it is poor public policy to continue to mandate or recommend spay or neuter for the purpose of preventing procreation. Our evolving understanding of the role of sex hormones in the canine endocrine system establishes spay and neuter to be as dangerous to our dogs as exposure to the deadly toxins DDT, BPA, PFOA, dioxins, phthalates, PCBs, atrazine (and similar herbicides), lead, cadmium and arsenic, to name just a few common endocrine disruptors. When dog guardians are asked, "*Would you bathe your dog in water laced with DDT daily?*" the answer is invariably, "*NO!!*" Unfortunately, if you neuter your male dog, the harm is essentially the same.

Due to the adverse effects of spay and neuter upon multiple organ systems in the canine, these procedures should not be utilized routinely as a means to prevent procreation. We currently recommend sterilization by the hormone-sparing methods we utilize on humans, i.e., tubal ligation and vasectomy. There are some veterinarians who believe hysterectomy is preferable to tubal ligation in order to avoid pyometra. We believe all sex organs, including the uterus, should be retained unless there is diagnosed disease in one of the sex organs which would dictate surgical removal.

With respect to public policy, the logical way to proceed would be to change the language in laws requiring specifically "spay" and/or "neuter" to instead require "sterilization". This change should not be controversial, because the change in terminology does not alter the intent of the law. The change would still allow for spay and neuter, but also allow the veterinarian to utilize tubal ligation, hysterectomy, vasectomy or any new less invasive hormone-sparing procedures the future may bring to prevent canine overpopulation. Public policy can dictate outcome, but should not dictate/limit the procedures available to the health care professional to reach the

mandated outcome. We believe an educated public and responsive veterinary community will render spay and neuter procedures essentially obsolete.

The damage we have done through spay and neuter is irreparable. However, there is evidence that hormone replacement therapy (HRT) can bring dogs better health, increase longevity, and assist with behavior issues in many cases. The ethical path is to actively support research for HRT in an attempt to rectify the errors we have made. Protocols for providing specific hormones, dosages and delivery systems must be established so that the local vet can be empowered to provide HRT to dogs suffering the effects of spay and neuter at the request of their guardians.

Introduction

Comprehensive analysis of the peer-reviewed science currently available to us indicates spay and neuter have far-reaching adverse effects on dogs that were not previously anticipated. These findings dictate re-evaluation of the blanket requirement for spay or neuter of all shelter dogs.

Objective

It is not our objective to dispute or question the current mandate to prevent pet overpopulation. To that end, in many states (including California) public policy dictates all dogs rescued from a private or public shelter, or purchased from a pet store, be spayed or neutered. It is our objective to determine whether spay and neuter comport with good public policy.

Evolution of the Science

When spay and neuter were first instituted, it was believed sex hormones were primarily relevant to reproduction. Therefore, removal of the organs that produce sex hormones seemed reasonable because reproduction was not desired in these dogs. Early studies generally found one or more negative outcomes of spay or neuter, but did not see the global damage done. (Edney, AT et al. 1986; Salmeri, KR et al. 1991; Spain, CV et al. 2004).

Current veterinary scientific study has established that sex hormones are responsible for much more than reproduction in dogs. As a part of the Endocrine System, **sex hormones affect canine growth and development, behavior, and a dog's susceptibility to major diseases including cancer, diabetes and other metabolic or endocrine-related disease.** The following conditions have been documented to be associated with spay and neuter in dogs:

1. Orthopedic problems
 - hip dysplasia
 - elbow dysplasia
 - CCL ligament tear in their knees (generally requires TPLO surgery)
 - Patellar luxation
 - Intervertebral disc disease

(Salmeri KR et al. 1991; Whitehair JG et al, 1993; Imada K. et al. 1995; Duval JM et al. 1999; Glickman LT et al. 2001; Spain CV et al. 2004; van Hagen MA et al. 2005;

Vidoni B et al. 2005; Duerr FM et al. 2007; Witsberger TH et al. 2008; DeLuke, AM et al. 2012; Hart BL et al. 2013, 2014, 2016; Jia, H. et al. 2016; Golds G et al. 2017; Dorn M, Seath, I.J 2018; Oberbauer AM et al. 2019; Zink, C. et al. 2023).

2. Cancer

- osteosarcoma
- hemangiosarcoma
- Lymphosarcoma
- mast cell tumor

(Ru G. et al. 1998; Ware WA, Hopper, DL 1999; Glickman LT et al. 1985, 2002; Rosenberger JA et al. 2007; Lord LK et al. 2007; Villamil JA et al. 2009; White CR et al. 2011; Zierau O et al. 2012; Hart BL et al. 2013, 2014, 2016; Zink MC et al. 2014; Oberbauer, AM et al. 2019; Zink, C. et al. 2023).

3. Diseases of the endocrine (hormone) systems

- hypothyroidism
- Cushings Syndrome and Atypical Cushings
- Type 2 diabetes
- Hyperestrinism and Alopecia (hair loss)
- Allergies (atopic dermatitis)
- Obesity

(Samaan NA et al. 1979; Edney, AT et al. 1986; Panciera DL 1990, 1994; Viau V1, Meaney MJ 1996; McGreevy PD et al. 2005; Lund EM et al. 2006; Oliver JW 2002, 2007; Shota Janjgava et al 2014; Oberbauer, AM et al. 2016, 2019; Zink, C. et al. 2023).

4. Behavior problems

- aggression towards people and other dogs
- fear and anxiety
- reactivity to touch or handling
- cognitive impairment

(O'Farrell V, Peachey E 1990; Hart BL 2001; Spain, CV et al. 2004; Serpell JA et al. 2006, 2018; Hyeon HK et al. 2006; Reisner IR et al. 2007; Rocca WA et al. 2012; Zink MC et al. 2010, 2014; Mongillo P et al. 2017, Koebele SV et al. 2019; Zink, C. et al. 2023).

Unfortunately, in the minds of the veterinary community, regulating agencies and humane organizations, the aforementioned adverse outcomes have not been sufficient to warrant discontinuation of spay and neuter. Professor Emeritus Dr. Benjamin Hart and Professor Lynette Hart of UC Davis School of Veterinary Medicine, have authored numerous studies regarding the canine health implications of spay and neuter. Based upon their findings, they have suggested in various media outlets and personal communications the wisdom of moving to hormone-sparing

sterilization such as tubal ligation and vasectomy. (Noga, 2013) (Personal communication, 2019) Their recommendations have been wholly ignored.

Some veterinarians are recommending delay of spay and neuter to avoid the developmental deformities associated with inadequate sex hormones prior to physical maturity. The 2023 AVMA study regarding spay and neuter states:

“Our most important finding was that longer duration that gonads [ovaries or testicles] were present, regardless of reproductive status, was associated with fewer general health problems and [fewer of] both problematic and nuisance behaviors. It was also associated with an increased lifespan. Because VS and OSS permit dogs to experience longer gonadal hormone exposure times, these data suggest that, when electing surgery to prevent reproduction, dogs might benefit from these alternative surgeries with respect to general health and experience better behavior outcomes compared to undergoing traditional spay-neuter surgery. Delaying traditional spay-neuter surgery could offer similar benefits.” (Zink, C et al. 2023).

The final statement regarding the potential benefits of merely delaying spay or neuter ignores the metabolic, immune-related, stress mediating and behavioral functions of sex hormones that are required for the entirety of the dog's life.

Other veterinarians insist that spay is necessary to avoid pyometra (infection of the uterus). With respect to pyometra two salient points must be made:

- Spay (ovariohysterectomy) and even hysterectomy can prevent pyometra, **if and only if the uterine removal is complete**. If the removal of the uterus is incomplete, this opens the dog up to further complications, i.e., "stump pyometra", that can be fatal as well. The danger of a delayed diagnosis is high because the veterinarian is not including pyometra in a differential diagnosis as the uterus is believed to be gone. The early diagnosis of pyometra is critical for survival.
- The diagnosis of pyometra does not dictate removal of the uterus. Depending upon the circumstances of the condition and the timing of the diagnosis, peer-reviewed studies indicate that most pyometra cases can be resolved with carefully selected medications and do not require surgical intervention. (Breitkopf M et al. 1997; Gobello C et al. 2003; Gogny A, Fiéni F 2016)

Significant concern exists with respect to how often a part of the uterus is left inside the female dog after spay. A quote from *"Veterinary Practice News"* follows:

“The everyday canine ovariohysterectomy (OVH) is a procedure that’s both hard to master and easy to underestimate. Is there any other routine procedure we perform that compares to the canine spay for its high degree of difficulty and annoying unpredictability, not to mention its impressive complication rate? ...Not only does the OVH (or OVE) require a mastery of anatomy and high proficiency in tissue handling, it’s complicated by factors arising from the tremendous variability among dogs... (Khuly P 2013)

Dr. Khuly has endorsed tubal ligation and vasectomy as her choice of sterilization method for otherwise healthy dogs. (Khuly P 2010).

Spay and Neuter and the Lifespan of Dogs

The claims that spay and neuter are beneficial to the health of a dog and actually extend the lifespan of dogs must be addressed. Arguably, spay and neuter diminish the dog's ability to enjoy his or her life in happiness and good health. Further, when you understand the physiological outcomes of hormone deprivation inherent to spay and neuter, it becomes obvious that spay or neuter can only shorten the lifespan of dogs. What follows is a review of the evidence regarding spay/neuter and lifespan which we have presented to our readers for many years now. In January of 2023, the AVMA finally published a study (Zink, C et al. 2023) acknowledging spay/neuter is detrimental to the health, behavior and lifespan of dogs. However, because the study also concludes that, "*delaying traditional spay-neuter surgery could offer similar benefits*" (referring to hormone-sparing sterilization), we feel compelled to provide within this paper a more full explanation as to why spay/neuter *at any time* in a healthy dog's life is detrimental to their health, behavior and lifespan.

A review of the most current body of evidence with respect to human and canine aging and longevity follows: The first step will be to confirm the legitimacy of comparing the longevity of dogs and humans. Subsequently, I will detail how and why the current human and canine longevity studies substantiate the position that spay/neuter shortens dogs' lives.

Why is the dog an ideal model for aging research? In 2015, an article in the publication "Experimental Gerontology" seeks to answer that very question:

"The dog has already become a key model system in which to evaluate surgical techniques and novel medications because of the remarkable similarity between human and canine conditions, treatments, and response to therapy... Just as the dog offers a natural model for human conditions and diseases, simple observation leads to the conclusion that the canine aging phenotype also mimics that of the human." (Gilmore K Greer K 2015)

The Journal "*Clinics in Geriatric Medicine*" provides the latest diagnostic and therapeutic information in the field of human geriatrics. In their review "The Use of Estrogen in Older Women" (Birge SJ 2003), they conclude:

"...the estrogen deficiency state may be characterized as a state of accelerated aging".

Next, consider the results in the Nurses' Health Study, among the largest (and longest follow up at 40 years) investigations into the risk factors for major chronic diseases in women. It was found, compared with ovarian retention, bilateral oophorectomy (i.e., removal of the ovaries) at the time of hysterectomy for benign disease is associated with a decreased risk of breast and ovarian cancer. However, there is a corresponding increased risk of all-cause mortality, fatal and non-fatal coronary heart disease, and lung cancer. **In no analysis or age-group was oophorectomy associated with increased survival.** (Parker WH et al. 2009)

Other more limited studies confirmed the findings of the Nurses' Health Study:

“Bilateral oophorectomy performed before age 45 years is associated with increased cardiovascular mortality, especially with cardiac mortality. However, estrogen treatment may reduce this risk.” (Rivera CM et al. 2009)

Subsequently, the authors of a specific canine study designed to determine whether lifetime retention of ovaries was associated with exceptional longevity found:

“Our results mirror the recent findings from more than 29,000 women in the Nurses' Health Study. In that study, women who had elective hysterectomy with ovary sparing had lower overall mortality than those who underwent hysterectomy with ovariectomy. Taken together, the findings from dogs and women support the hypothesis that early life physiological influences, such as ovarian hormones, lay the foundation for adult health outcomes including longevity.” (Waters DJ et al. 2009)

Questions have persisted as to whether presence of the ovaries conferred longevity, or perhaps the actual process of reproduction and/or the number of offspring or other variables conferred longevity. Studies of both humans and dogs have provided answers to these questions:

The human study concludes:

“... we analyzed the relationship between longevity and menopause, including other factors that impact “ovarian lifespan” such as births, oophorectomy, and hormone replacement therapy. We found that later onset of menopause was associated with lower mortality, with and without adjusting for additional factors (years of education, smoking status, body mass index, and marital status). Each year of delayed menopause resulted in a 2.9% reduction in mortality...”

“Our findings suggest that maintenance of HPG [hypothalamic-pituitary-gonadal(ovarian)] axis homeostasis is a predictor of mortality... We also found in our preliminary regressions that surgical and natural menopause at age 40 resulted in identical survival probabilities, as might be expected given that both result in the dysregulation of the HPG axis... These results support the maintenance of the hypothalamic-pituitary-gonadal axis in homeostasis in prolonging human longevity, which provides a coherent framework for understanding the relationship between reproduction and longevity.” (Yonker JA et al. 2013)

The study of dogs states:

*“To better understand the potential trade-off between female reproductive investment and longevity in an emerging model of human healthspan, we studied pet dogs to determine whether intensity of reproduction (total number of offspring) encumbered the likelihood of exceptional longevity. Instead, independent of reproductive investment, the duration of lifetime ovary exposure was significantly associated with highly successful aging. **Moreover, our conclusions are consistent with the hypothalamic-pituitary-gonadal***

(HPG) axis hypothesis of longevity proposed by Atwood and colleagues, in which longer lifetime gonad activity (i.e., delayed onset of menopause), rather than number of offspring, predicts longevity in women. (Waters DJ et al. 2013)

It seems abundantly clear that extensive research supports the finding that the lifespan of female dogs is shortened by spay (removal of estrogen producing ovaries and uterus) or even the removal of the estrogen producing ovaries alone, for the sole purpose of preventing reproduction. However, the veterinary community at large has chosen to rely upon other studies over time to justify their position of advocacy for spay and neuter. The most recent of these studies was published in the highly referenced open access scientific journal produced by the Public Library of Science (PLOS). The study concludes that the average age at death for dogs that had not been spayed or neutered (i.e., reproductive organs remain intact) was 7.9 years versus an average age at death of 9.4 years for spayed or neutered dogs. However, the study does contain an admission that **there is no ability to conclusively state that failure to spay or neuter causes a shortened lifespan.** The PLOS study states:

“Although a retrospective, epidemiological study such as this cannot prove causality, our results suggest that close scrutiny of specific causes of death, rather than lifespan alone, will greatly improve our understanding of the cumulative impact of reproductive capability on mortality.” (Hoffman JM et al. 2013)

Debunking the Myths

In scrutinizing the causes of canine death as discussed in the aforementioned PLOS study, with respect to spayed and neutered dogs, the study’s findings are consistent with the research presented in this paper, i.e., dogs that had been spayed or neutered were more likely to die from cancer or autoimmune diseases.

The PLOS study also concluded that intact dogs were more likely to die from trauma and/or any combination of five specific infectious diseases:

1. distemper
2. parvovirus
3. heartworm
4. intestinal parasites
5. blastomycosis

This study violates the research fundamental that you must endeavor to isolate one and only one relevant variable. If a study were commissioned to compare weight gain/loss between two groups, one consuming sugar free soda and the other consuming equal amounts of a sugar based variety, it would be impossible to draw any reasonable conclusions if other dietary components are not kept as identical as possible (e.g., carbohydrate intake). In the PLOS study, the relevant variable was intended to be reproductive status. However, it is evident that other contributing variables including vaccination status, medications taken, geographic location and lifestyle were not accounted for in the design of this study. This would serve to invalidate any conclusions drawn from this study.

Distemper and parvovirus incidence and death can dramatically be reduced by appropriate vaccination. Heartworm can essentially be eliminated by preventative medication taken on a monthly basis. There is **no** information in this study to tell us whether intact dogs who died from these illnesses were properly vaccinated or medicated to prevent these diseases or not. Therefore, vaccination status and whether preventive medication was given to an intact dog become additional relevant variables. If intact dogs were not properly vaccinated or medicated, how could one conclude they contracted these diseases and died in greater numbers because they were intact? It seems much more likely the dogs died because they weren't properly vaccinated to protect them from distemper or parvovirus, or medicated to prevent heartworm. It is impossible to draw **any** relevant conclusions regarding reproductive status and longevity until the obvious questions about vaccination and preventive medication are answered. Therefore, the statistics cited by the study regarding intact dogs dying from these three infectious diseases are meaningless in the context of reproductive status and must be discarded.

As to the two remaining infectious causes of death in intact dogs (i.e., intestinal parasites and blastomycosis), it does again appear there are intervening relevant variables which do not allow us to draw significant conclusions from this study. With respect to intestinal parasites and blastomycosis, geographical location and lifestyle are **very** significant. Intestinal parasites are more likely to be encountered in rural or mountainous areas and within the context of activities like hunting rather than urban or suburban environments. Blastomycosis is found in a very specific geographical area:

*“Blastomycosis is a systemic fungal infection caused by the dimorphic fungus **Blastomyces dermatitidis**...**Dogs at greatest risk for developing clinically apparent blastomycosis are 2- to 4-year-old intact male large-breed dogs living in Mississippi, Missouri, and Ohio river valleys and the Middle Atlantic states**...This group of dogs has a greater tendency to roam and to sniff and dig in the soil, resulting in greater exposure to the organism. Sporting dogs and hound breeds are predisposed, most likely because of increased exposure to high-risk areas during hunting. Residence near a river or lake has been demonstrated to increase the risk of infection.”* (Gaunt MC, Taylor SM 2009).

Because blastomycosis is so specific to certain geographical locations, and even to certain recreational activities, the location of the dog's residence is critical if one were to make legitimate comparisons of lifespans between spayed and neutered dogs and intact dogs. If both groups of dogs had similar patterns of activity and could possibly be exposed to blastomycosis, and the intact dogs succumbed to the disease while the spayed or neutered dogs were able to fight it off, there might be a legitimate basis to argue spayed or neutered dogs have healthier immune systems which could account for their extended lifespan. The key for comparison is that both groups had to potentially be exposed to blastomycosis. The failure of the PLOS lifespan study to provide any information as to the location of residency for the spayed or neutered vs. intact groups of dogs is noteworthy and certainly limits our ability to accept their conclusions without great skepticism.

Furthermore, since distemper, parvovirus and blastomycosis generally kill dogs of a younger age, the demise of dogs from these deadly diseases at a young age will serve to skew the lifespan statistics markedly down for intact dogs.

Oddly enough, subsequent to this lifespan study, more information has been developed regarding the efficacy of heartworm preventative medications. In 2016, a small study at Auburn University discovered a preventive-resistant JYD-34 strain of heartworm only found in the Mississippi Delta region, which proved to be susceptible to Advantage Multi heartworm preventative, but not Heartgard Plus, Interceptor, or Revolution. (Blagbum BL et al. 2016). This information is not presented as a criticism of this PLOS study, but it does show that had the PLOS study tracked the location of dogs who succumbed to heartworm, and their preventive medication status, the data might have alerted them to the anomalous heartworm strain in the Mississippi Delta region years earlier.

The inclusion of “*death by trauma*” in the PLOS study is another red flag. Because this study is attempting to assess medical outcomes based upon reproductive status, there were certain dogs excluded from the evaluation. For example, congenital causes of death (i.e., a disease or physical defect one is born with) were removed from subsequent analysis because they would have been present before the time that sterilization was or was not elected.

Likewise, trauma should have been eliminated in the study with respect to the calculation of lifespan for all dogs as it has no clear relationship to the actual health of the dog at the time of its death. Some might argue intact dogs are inclined to roam due to the influence of sex hormones. In an urban/suburban environment that could result in more deaths due to dogs roaming without supervision and being hit by cars. However, considering the inclusion of blastomycosis as a leading cause of death among this group of intact dogs, it is highly unlikely the intact population was residing in an urban/suburban area. Death by trauma was more likely associated with the lifestyle of a hunting dog. The longevity of the intact or altered dog group can be dramatically skewed based upon the risks for injury or death that are lifestyle related.

Close evaluation of the PLOS lifespan study reveals a comparison of what appear to be two disparate geographical populations with very different lifestyles. Rural dog guardians are less likely to spay or neuter their dogs, especially when they utilize these dogs for hunting, and would be less inclined (and perhaps not legally required) to follow the dictates of the veterinary profession with respect to wellness exams and vaccinations. The lifestyle of a rural dog generally involves different activities (e.g., hunting) where the dog may encounter wildlife and venture into wild areas without continuous and direct owner supervision, thus increasing the risk of traumatic harm to the dog. On the other hand, dogs in most urban/suburban areas are required by law to be licensed, and licensure requires proof of vaccination. Doggy day care, boarding facilities and dog parks – commonplace habitats for the urban/suburban canine – all require proof of vaccination as well. The idea that this study can be utilized by veterinarians or anyone else as evidence that spayed or neutered dogs have a longer lifespan than intact dogs is misguided at best. We would suggest that the authors themselves (see their aforementioned quote on this page) acknowledge **this study cannot establish that spayed or neutered dogs have longer lifespans because they were spayed or neutered.**

Aging and Stress

Extensive studies, as cited above, establish spay and the removal of sex hormones, especially estrogen, in a female dog decreases longevity. With respect to male dogs, absent any parallel to

the Nurses' Health Study, it is most relevant to provide other published scientific research which substantiates long held theories about homeostasis, aging and stress.

1. **Aging renders the individual less able to maintain homeostasis and/or adapt to stress.** (Dilman Vladimir, Dean Ward 1992). Note: the authors describe their thesis as follows - aging is primarily caused by a progressive loss of receptor sensitivity of the hypothalamus and pituitary (in the brain) to negative feedback inhibition. While this loss of sensitivity is essential for normal growth and development, it is also the cause of post-maturational diseases, aging and death.
2. **Chronic stress can accelerate the aging process.** (Sapolsky RM et al. 1986, 2002). Note: The authors describe the results of their study which showed that if male rats are exposed to chronic stress, the aged male rats develop runaway glucocorticoid production via dysregulation of the Hypothalamus-Pituitary-Adrenal (HPA) axis. (Mastorokos G1, et. al. 2006), (McEwen BS, 2006, 2007), (Constantine Tsigos et. al., MD, PHD, 2016).

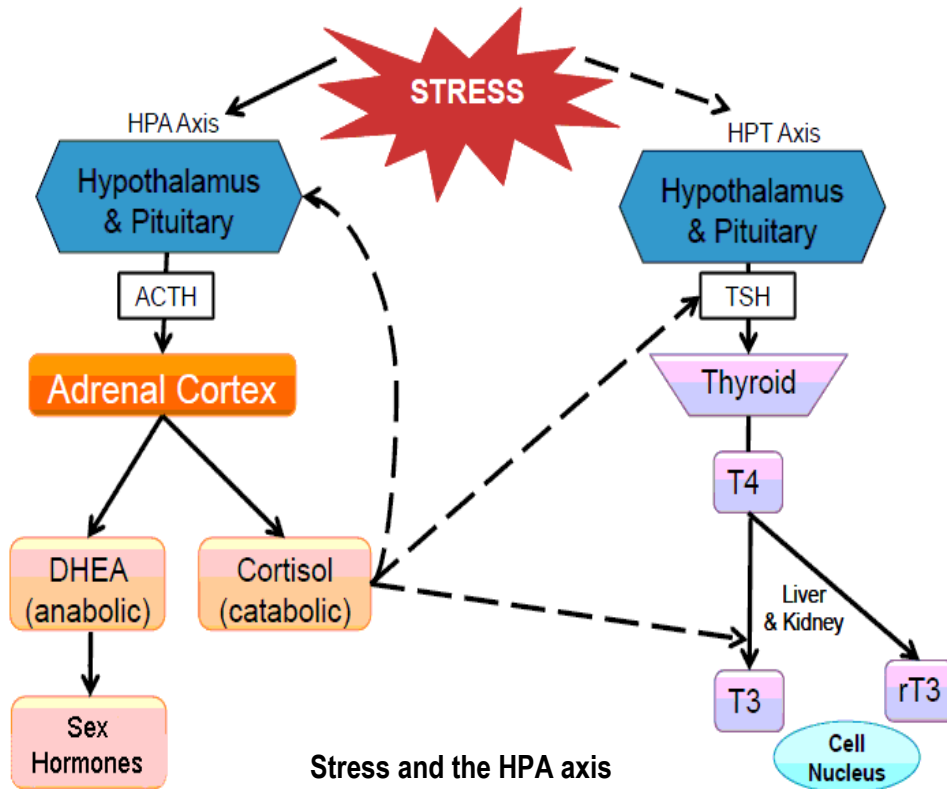
A Mayo Clinic study focused upon regulation of the HPA axis and cortisol production. The study confirmed age, gender and sex steroids are salient physiologic factors that determine the magnitude and duration of stress-adaptive cortisol production, albeit via mechanisms that are essentially unknown in the human. The study concludes:

“Understanding the regulation of normal HPA outflow is significant, because chronically increased glucocorticoid concentrations correlate with metabolic features of syndrome X (visceral adiposity, insulin resistance, low high-density lipoprotein levels, high blood pressure, increased triglyceride levels), physical frailty (reduced bone and muscle mass, decreased aerobic capacity), immune suppression, hypogonadism, growth hormone (GH), and insulinlike growth factor 1 deficiency and impaired memory and spatial cognition. Aging itself is associated with similar changes.” (Veldhuis, JD MD et al. 2013)

Current scientific studies about stress and aging focus in on the HPA axis and its ability to self-regulate. It has been observed with respect to the relationship between HPA regulation, homeostasis and aging in the spayed or neutered dog is that there is a cliff edge these animals go over when the body can no longer compensate adequately for the removal of the organs. This failure to compensate is hastened by stressors/factors, which could include environmental stress, surgery, trauma, rehoming, diet and body composition (including insulin resistance, etc.), iatrogenics (e.g. medications). However, in most dogs, if they have a stable home and minimal stressors, the dog may reach middle age before they are unable to compensate and their HPA axis becomes completely dysregulated.

The diagram below illustrates the relationship between stress and the HPA and HPT axes. The hypothalamus and pituitary glands direct both adrenal and thyroid gland hormone production. The adrenal glands in both people and dogs are responsible for producing cortisol in response to stress. However, after spay or neuter, the dog's adrenal glands must take on the additional responsibility of manufacturing sex hormones. As stress response is the primary responsibility for the adrenal glands, excessive or chronic stress will force the adrenals to devote their energy to cortisol production, to the exclusion of the production of sex hormones. Due to negative feedback mechanisms, chronic adrenal stress depresses hypothalamic and pituitary function. The

hypothalamus and pituitary glands control thyroid production, consequently stress that disrupts the HPA axis will also suppress thyroid function.



HPA axis dysregulation explains how a spayed or neutered dog's **stress response system** fails them. Stress will predictably cause inadequate production of DHEA and sex hormones, thyroid dysregulation and a failure of the hypothalamus and pituitary to secrete numerous other hormones required for a stable metabolism. One can envision the hormonal disruption spreading outward to other body systems like a pebble's wake when thrown into a pond.

Spay and neuter, by dysregulating the hormonal axes of dogs (i.e., the hypothalamus-pituitary-gonadal, hypothalamus-pituitary-adrenal and hypothalamus-pituitary-thyroid axes) can be shown to accelerate the aging process, thereby compromising a dog's quality of life and shortening their lifespan.

The Global Perspective About Spay and Neuter's Damage

The adverse effects of spay and neuter on the dog's endocrine system are far greater than current veterinary research has established. Removal of the organs primarily responsible for producing sex hormones, i.e., ovaries, uterus and testes, means that spay and neuter:

1. Alter the production of sex hormones
 - Generally the production of estrogens, testosterone and progesterone is reduced.
 - In some cases (usually male dogs), for reasons unknown, there is an overproduction of estrogens. (Oliver JW 2002, 2007).
2. Alter the activity of sex hormones subsequently produced by the adrenal glands, (due to the absence of ovaries, uterus and testes). For example:
 - Levels of sex hormones produced exclusively by the adrenal glands may be inadequate to exert negative feedback, as they do in the intact dog, upon certain hormone systems such as the hypothalamus-pituitary-adrenal axis (HPA axis) and the hypothalamus-pituitary-gonadal axis (HPG axis).
 - Dysregulation of the HPG axis created by spay and neuter generally results in heightened levels of luteinizing hormone (LH). Excess LH can affect the way many hormones function, including adrenal sex hormones, by interfering with or altering receptor activity in many tissues (Kutzler MA 2020).
 - Dysregulation of the HPA axis due to spay or neuter often creates excess levels of cortisol. Excess cortisol is the underlying condition which defines Cushings disease (Oliver JW 2002, 2007). Excess cortisol also provides negative feedback to block the production of thyroid hormone in dogs. Spay and neuter has been found to be correlated with a three fold increased risk of hypothyroidism (a lack of thyroid hormone) as compared to intact dogs (Panciera DL 1990, 1994).

Consider the following quote as taken from the latest edition of the subject-expert reference, "Comprehensive Toxicology":

"EDCs [i.e., endocrine disrupting chemicals] disrupt the endocrine system directly or indirectly by altering hormone levels, affecting the synthesis or metabolism of hormones, or changing the way hormones elicit their functions. Critical reproductive hormones, such as progestins [progesterone], androgens [testosterone], and estrogens, are the primary targets of many EDCs." (Dávila J et al. 2018).

Although spay and neuter are surgical procedures (not chemicals), clearly a comparison of the activity of EDCs to the effects of spay and neuter confirms spay and neuter function as extremely efficient endocrine disruptors.

It might surprise you to find the names of some of these EDCs include DDT, dioxin, BPA, phthalates, PFOA, atrazine (herbicide), PCBs and arsenic. In males, for example, DDT is one EDC known to "chemically castrate" (i.e., neuter) its victims. (Daxenberger A 2002; Hayes TB

2010) Extensive studies have shown these chemicals to be extremely damaging to humans and wildlife. **You must understand that spay and neuter create the same type of harmful changes inside your dog's body as these dangerous endocrine disrupting chemicals have been documented to create.** Most people believe these chemicals are dangerous because they are carcinogens, i.e. chemicals that cause host cells to mutate and become cancerous. That may be true in part, but the manner in which these chemicals do their damage is by interfering with our hormones, primarily our sex hormones. That is why these chemicals are classified as endocrine disruptors rather than carcinogens. After substantial research, **no studies asserting the benefits of exposure to endocrine disrupting chemicals have surfaced.**

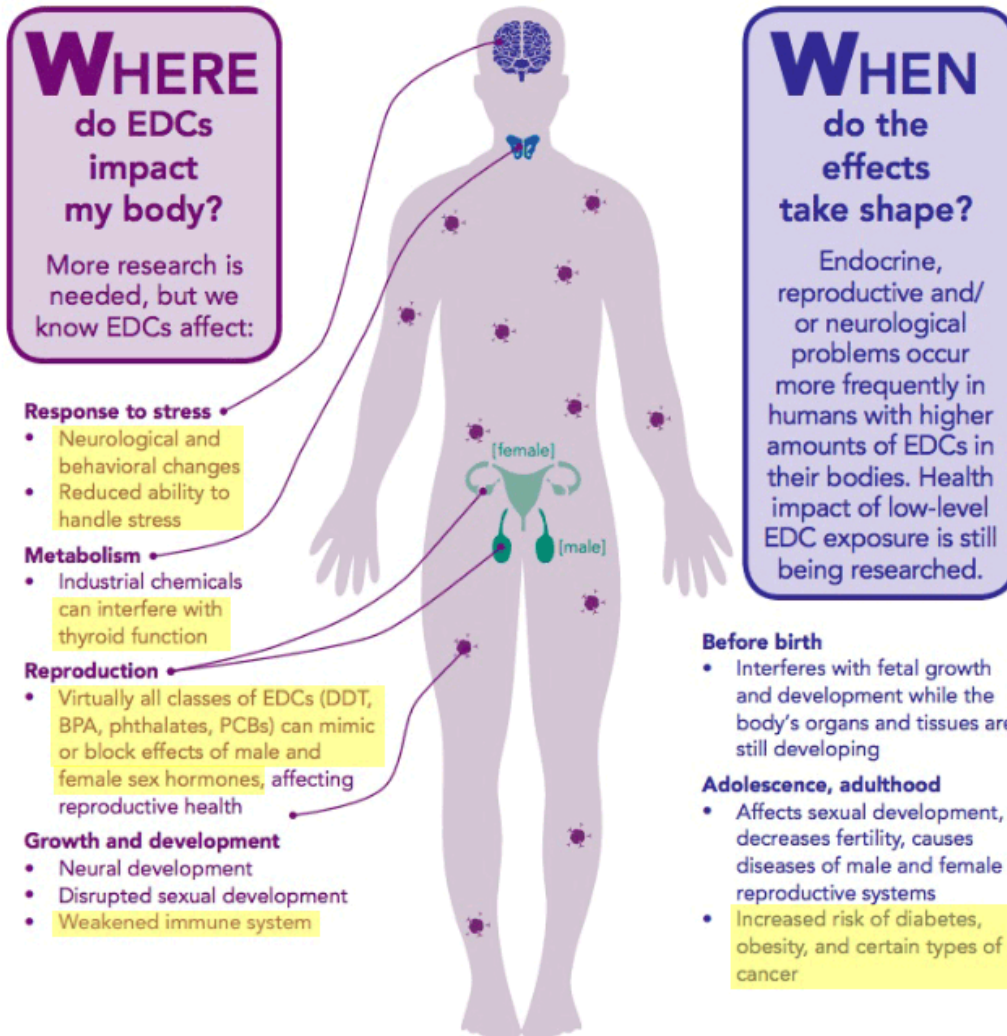
At a recent European Union (EU) conference on endocrine disruptors, R. Thomas Zoeller, PhD, an invited spokesperson for the Endocrine Society, stated:

“It’s important for regulating agencies to understand that hormones control elements of development that are irreversible when disrupted. We are facing a continuing pandemic of chronic disease if we do not act now.”

The conclusions of Dr. Zoeller, with respect to endocrine disruptors, are remarkably similar to the conclusions in a 2013 UC Davis study (Hart BL et al. 2013) of the effects of spay/neuter:

“Because [spaying and] neutering can be expected to disrupt the normal physiologic developmental role of gonadal [i.e., sex] hormones on multiple organ systems, one can envision disease syndromes...”

Impact of EDs/EDCs



As stated in the diagram above, “Virtually all classes of EDs can mimic or block effects of male and female sex hormones” (Endocrine Society, Hormone Health Network website). When we compare the effects of spay/neuter with the effects of EDs/EDCs in the graphic above, the high level of correlation serves to confirm that **spay/neuter affects a dog’s organ systems in a similar manner as exposure to most EDs/EDCs (e.g., DDT, dioxin, phthalates, BPA, PFOA, PCBs)**. This is critically important because despite the recent emergence of studies that are connecting spay/neuter to orthopedic deformities, metabolic disease, behavior problems and cancer, the veterinary community is *still* defending spay/neuter as a procedure that is beneficial for our dogs.

The table below allows a comparison of the documented adverse effects of EDCs, and the adverse effects of spay and neuter. As expected, these two medical conditions have a great deal in common:

ED/EDC Disease Related Symptoms	Spay/Neuter Correlating Impairment
Neurological changes	Increased cognitive impairment (Hart BL 2001; Rocca WA et al. 2012; Mongillo P et al. 2017; Koebele SV et al. 2019)
Behavioral changes	Behavioral changes in females and males ((O’Farrell V, Peachey E 1990; Hart BL 2001; Spain, CV et al. 2004; Serpell JA et al. 2006, 2018; Hyeon HK et al. 2006; Reisner IR et al. 2007; Rocca WA et al. 2012; Zink MC et al. 2010, 2014; Zink, C. et al. 2023).
Reduced ability to handle stress	Sex hormone production is additional burden on adrenal glands. When a spayed/neutered dog experiences high stress situations, the adrenal glands can become overwhelmed. (Sapolsky RM et al. 1986, 2002; Veldhuis, JD MD et al. 2013).
Compromised thyroid function	Three fold increased risk of hypothyroidism as compared to intact dogs (Panciera DL 1990, 1994).
Weakened immune system	Increased risk of persistent or recurring urinary tract infections by a factor of 3-4. (Seguin MA et al. 1989-1999; Spain CV et al. 2004). Increased risk of recessed vulva, vaginal dermatitis, and vaginitis. (Verstegen-Onclin K, Verstegen J 2006) Increased incidence of allergic reactions. (Moore GE et al. 2005; Lund E 2008)
Increased risk of Diabetes	Increased risk of Diabetes with hypothyroidism, Cushings and hyperestrinism, all emerging diseases (Oliver JW 2002, 2003, 2007; Polderman KH1 et al. 1994; de Bruin C et al. 2009; John Schieszer, MA 2014; Bao X, et al. 2016; Viau V1, Meaney MJ. 1996).
Increased risk of obesity	Increased risk of obesity by a factor of 1.6-2 in females, and triple the risk of obesity in males. It is common and associated with many health problems (Edney, AT et al. 1986; McGreevy PD et al. 2005; Lund EM et al. 2006).
Increased risk of Cancer	Increased incidence of Cancer (Teske E et al. 2002; Ru G et al. 1998; Cooley DM et al. 2002; Prymak C et al. 1985; Ware WA, Hopper, DL 1999; Hart BL et al. 2013, 2014; Beauvais W1 et al. 2012; Palmer, C et al. 2012; Zink MC1 et al. 2014; Zierau O et al. 2012; Villamil JA et al. 2010; Zink, C. et al. 2023).

The Adverse Effects of EDCs and Spay and Neuter

Once a dog has been spayed or neutered, their endocrine system has been forever altered. There is no going back to optimal health, despite best efforts. **Spay/neuter is the *ultimate* Endocrine Disruptor, and it is never a responsible option for a young, healthy dog.**

Public Policy and the Precautionary Principle

It is sometimes argued that some dogs seem to thrive despite being spayed or neutered, and the fact that results for each dog are different based upon their genetic makeup, breed, age of spay or neuter, stress in their environment, nutrition, exposure to recognized EDs in their immediate environment, etc. makes it hard to establish good public policy.

The converse argument would be that the adverse effects of spay and neuter upon multiple organ systems in the canine dictate these procedures should not be utilized routinely as a means of sterilization. We should move to sterilization procedures which preserve the sex hormones, such as tubal ligation and vasectomy.

Oddly enough, the comparison of EDs to spay and neuter provides the solution as to how to establish good public policy in this circumstance. Endocrine Disruptors in our environment have fostered the use of the "*Precautionary Principle*" (PP) in public policy.

The "*Precautionary Principle*" is defined as:

"When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause-and-effect relationships are not fully established scientifically." (from the January 1998 Wingspread Statement on the *Precautionary Principle*)

As previously stated, the PP was initially utilized to establish public policy with respect to potentially harmful environmental concerns, e.g. endocrine disruptors. However, over time there are many other disciplines who have recognized the value of the PP:

"At its core, the precautionary principle contains many of the attributes of good public health practice, including a focus on primary prevention and a recognition that unforeseen and unwanted consequences of human activities are not unusual...the precautionary principle needs to be applied to public health actions as well as to actions pursued by government and industry for competitive and economic reasons." (Goldstein, 2001)

The key elements of the *Precautionary Principle* are:

1. *Taking anticipatory action to prevent harm in the face of scientific uncertainty.* (Gilbert SJ, 2019)

The issue of scientific uncertainty is certainly in play with respect to spay and neuter. In the face of numerous studies showing behavioral, orthopedic and metabolic damage caused, as well as an increased incidence of generally fatal cancers, the veterinary community continues to assert spayed and neutered dogs live longer. The study most veterinarians rely upon to claim that spayed and neutered dogs live longer is fatally

flawed (see analysis of the PLOS study herein). Based upon a thorough review of the studies relevant to longevity in dogs, as well as the universally held beliefs with respect to endocrine disruption, it is clear spayed and neutered dogs live shorter and less healthy lives. Finally, some 7 years after we came to our conclusions regarding the damage inflicted by spay/neuter, the AVMA has published a study acknowledging the detriment spay neuter causes to the health, behavior and lifespan of our dogs. Yet, this study *still* holds out the idea that delay of spay and neuter may be as effective as hormone-sparing sterilization in protecting the health, behavior and lifespan of our dogs. This is not a reasonable excuse to maintain the status quo. Based upon the documented irreparable harm spay and neuter can cause, there must be a change made to current public policy. Forcing neuter of a shelter dog at an early age - often as young as 3 months - clearly is inhumane. (Palmer C, 2012) The value of the *Precautionary Principle* is that it helps policymakers make good decisions despite scientific controversy.

2. *Exploring alternatives, including the alternative of "no action."* (Gilbert SJ, 2019)

In this circumstance, we are fortunate to have alternatives that are equally as effective in accomplishing the primary intention of the public policy - the control of overpopulation. Alternatives would be tubal ligation, hysterectomy (a less desirable alternative) and vasectomy which are utilized quite effectively in the human population. These methods of sterilization have none of the ill effects of spay and neuter because they spare the all-important sex hormones. The dog's physical development, behavior, metabolism, and immune system will be unchanged.

3. *Considering the full cost of environmental and health impacts over time.* (Gilbert SJ, 2019)

There are financial, emotional and societal costs to be considered. The expense of providing hormone-sparing procedures to dogs should be less than a traditional spay or neuter, as these are less invasive procedures. At worst case, the cost would not exceed that of spay and neuter.

The expense of medical care for a spayed or neutered dog can be prohibitive. Surgery to repair orthopedic deformities, and treatment of cancer, diabetes and metabolic disease are all quite costly. Sometimes families cannot afford to provide ideal care.

The physical harm to the dog is passed on to its adoptive family as an emotional burden, because the physical and behavioral issues will be lifelong. The potential loss to cancer at an early age, the inability to pay for care needed or the behavioral issues, which may include aggression, can be not only harmful, but emotionally devastating to a family.

From a societal standpoint, spay and neuter pose the following problems:

- *"The beneficial effects of gonadectomy are underpinned by the need to reduce the number of unwanted companion animals. Thousands of dogs are euthanased in*

shelters and pounds annually in many developed countries. However, shelters are inundated by dogs that are most commonly surrendered because they display undesirable behaviours. So the current findings present the paradox that castration may reduce the numbers of unwanted dogs but may also increase the likelihood of problem behaviours that reduce the appeal of the castrated dogs and make them more vulnerable to being surrendered.” (Serpell JA 2018)

- There is no established protocol available to replace lost hormones or balance hormones that have been overproduced due to spay or neuter. Even when a dog suffers from metabolic or behavioral problems that we can attribute directly to hormone imbalance brought on by spay or neuter, we are generally at a loss as to how to remedy the situation. The damage is truly irreparable. **There needs to be recognition of the harm spay and neuter create, and studies funded and completed to establish protocols to balance hormones so as to minimize ongoing deterioration of the spayed or neutered dog's health.**

4. *Increasing public participation in decision making.* (Gilbert SJ, 2019)

Personal communications with dog guardians who have spayed or neutered their dog and noticed immediate adverse effects indicate they are devastated to discover they have actually irreparably harmed their family member. Further, there is great animosity towards the veterinarians who recommended spay or neuter without providing "informed consent".

In the case of shelter dogs who are required by government agencies or "humane" organizations to be spayed or neutered before adoption, when the dog develops a behavioral or serious medical problem, guardians utilize the internet to find answers. When guardians discover their dog has been "damaged" permanently they feel betrayed. By doing the "socially acceptable" thing in rescuing a dog rather than rewarding a backyard breeder, they have acquired a dog with lifelong health and behavioral issues. Many indicate they will not adopt from a shelter again. The requirement for spay or neuter is an outdated public policy which is counterproductive.

5. *Shifting the responsibility for providing evidence to the proponents of an activity.* (Gilbert SJ, 2019)

The veterinary community has been loathe to relinquish spay and neuter, but at this time the Precautionary Principle would demand that the veterinary community justify continuing the recommendation for spay or neuter. The logical comparison between endocrine disrupting chemicals and spay/neuter, both of which have similar disruptive effects upon sex hormones in dogs is immutable. Therefore, barring scientific discovery that endocrine disruption is beneficial to humans, pets and wildlife, there is no defense to the veterinary community's continuation of spay and neuter as a means to control our canine population.

Further, if you consider the precautionary principle as it relates to medical decision-making, consider that one of the oldest rules in medical decision-making is the adage “an ounce of prevention is worth a pound of cure.” For most diseases, the harms and costs entailed by preventative measures are much less than the harms and costs associated with the disease. (Resnik, DB 2004)

For spay and neuter, there is consensus among veterinary practitioners who provide hormone replacement/balancing that our best efforts to restore hormonal homeostasis fall far short of ideal. Endocrine systems are incredibly complex. Disruption of sex hormones, especially at a young age, causes improper development of much more than the veterinary community is currently aware of. For example, sex hormone disruption in rats has been shown to interfere with proper development of tooth enamel. (Jedeon K et al. 2014) From a medical perspective, and in keeping with the Precautionary Principle, preventing procreation while maintaining sex hormones undisturbed, is a far better medical decision than removing hormones by spay and neuter and trying to manage the damage later.

Conclusion

Veterinary schools should be changing their curriculum to preferentially instruct students to perform tubal ligations and vasectomies, and the veterinary community should be pressing legislatures to require "sterilization" rather than spay and neuter in laws relating to shelter dogs.

Last but not least, it would be unethical for the veterinary community to fail to take responsibility for the harm they have inflicted upon hundreds of thousands of dogs and their families. Studies to investigate hormone balancing protocols to help offset the spay/neuter damage should be funded and initiated immediately. Further, efforts must be made to make this reparative care affordable.

For a more comprehensive explanation of the entirety of this issue, please review our website *HealthyAndHappyDog.com*.

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