Breeders Session

St. Louis, Missouri

August, 16, 2008

Breeder Program Schedule

8:00 – 8:15a.m.	**WELCOME** – DR. CHERYL LOPATE
8:15 – 8:45a.m.	**CONSIDERATIONS FOR USE OF CHILLED SEMEN** – DR. GEORGE SEIER
8:45 – 9:15a.m.	**CONSIDERATIONS IN THE USE OF FROZEN SEMEN** – DR. GEORGE SEIER
9:15 – 10:15a.m.	**BREEDING OPTIONS IN THE BITCH** – DR. REBECCA KESTLE
10:15 – 10:30a.m.	**BREAK**
10:30 – 11:30a.m.	**MASTITIS AND COMMON MAMMARY DISORDERS OF THE PREGNANT AND NON-PREGNANT BITCH** – DR. ANNE TRAAS
11:30 – 12:30p.m.	**POSTPARTUM DISORDERS** – DR. KIRK ESMOND
12:30 – 1:30p.m.	**LUNCH**
1:30 – 2:00p.m.	**MISCONCEPTIONS ABOUT NUTRITION** – DR. DEB GRECO
2:00 – 2:30p.m.	**HOW TO READ AND UNDERSTAND A DOG FOOD LABEL** – DR. DEB GRECO
2:30 – 3:15p.m.	**REGULATORY ISSUES REGARDING CANINE REPRODUCTION** – DR. JERRY EBER
3:15 – 3:30p.m.	**BREAK**
3:30 – 4:30p.m.	**OFA VS PENN HIP** – DR. RAY CALKINS
4:30 – 5:30p.m.	**ABNORMALITIES OF THE ESTROUS CYCLE** – DR. SCOTT PRETZER

Considerations for the Use of Chilled Semen

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When considering the type of artificial insemination (AI) to use, remember there are no guarantees. Whether we choose chilled semen or frozen semen, one must remember they both have disadvantages since every time we manipulate semen, we compromise its life span. But it is not all bad news, as we can be very successful no matter what type of artificial insemination we ultimately choose. In order to be successful there are a number of considerations and decisions that must be made in preparation for each individual breeding

First and foremost is to plan the breeding ahead of time. Please don't make it any emergency. Start working on your breeding plans months prior to your female coming into heat. Or if you own the male, do your homework prior to the actual insemination.

Here is a list of questions that should be asked:

- Will the male be available when needed?
- What is the fertility and breeding history of male?
    - Has a recent semen evaluation been performed?
    - Has a longevity assessment been performed?
    - When was his last litter born and what was its size?
    - When was he collected last?
    - Has chilled semen ever been shipped and resulted in a normal litter?
- What is the fertility and breeding history of female?
    - How many previous litters has she had?
    - Has she ever failed to conceive?
    - If so, has an infertility work-up been performed?
- What is level of expertise of the breeders (both bitch and dog)?
- What access to veterinary services is there and what is the level of services and expertise?
- What is health status of the dogs including Brucella and DNA status on both male and female?
- What are the budget constraints and just how important is this breeding to your kennel?

Whatever you have planned, there will likely be some last minute changes, so always have a back-up plan.

There are many considerations for the male. We want to make sure the male is available, is in good health, and is both fertile and not being overused. He could be on the show circuit, or otherwise be unavailable. We need to make sure he has been collected successfully in the setting that he will be subjected to at the time of the planned breeding. Whether it is a dog show, veterinarian's office, hotel room or at home, has it worked in this setting? Some shy dogs need a teaser and others need the help of medications for an adequate collection. We want to know just how fertile the dog is, close to the time of the intended breeding, not 6 or 12 months ago. The time of year may affect fertility (i.e. summer heat). If the male has fertility issues it may be necessary to adjust the type of AI being performed so that an adequate breeding dose is delivered to the uterus.

We want to make sure the semen extender available has been used on this male successfully in the past. It is nice to have a chill test record on the semen with the type of extender being used. We need to know how long the semen will live, as weekend or Monday breedings will almost assuredly be needed at some time. It is nice to have extra fresh extender sent along with the shipment if needed. The type of shipping available must be determined – FedEx, UPS, or commercial airlines. In order to fly semen, the veterinarian or breeder must have 'known shipper' status. Some areas do not have Saturday delivery available so that semen will have to be picked up at a FedEx office.

It is important to know the method of insemination – vaginal, transcervical (TCI) or surgical. The volume of semen needed is decreased for TCI and surgical inseminations, and may require centrifugation to concentrate. The veterinarian on the shipping end may or may not have access to a variable speed centrifuge.

There are also many considerations for the female. Obviously it is preferable to have a fertile female with no major health considerations. It is nice to know of any past breeding attempts and their success rates along with the method of insemination used. The bitch's heat cycle history is also very helpful, especially if ovulation timing (OVT) has been performed in the past. We need to know if this is a normal cycle, and hormonal levels (progesterone concentrations) will need to be performed to determine the optimal time for the insemination(s). All this information will help us decide on the type of insemination to be used. If the bitch has fertility problems she should be evaluated prior to the breeding and treated appropriately. Sometimes a change in AI techniques is necessary to adjust for fertility issues with the bitch.

In short, to be successful with chilled semen breeding we need quality semen, placed into a healthy uterus at the right time!

As a breeder you should become educated and trained in all the aspects of collection, shipping, OVT and AI. Your veterinarian can help you with this. You must not be bashful and be willing to learn, and be willing to fail. Even though failure is a fact at times, it can be minimized.

According to the American Kennel Club (AKC) a veterinarian must collect and prepare any shipped semen and a veterinarian on the bitch end must inseminate it. Failing to utilize a veterinarian for either end of the process makes it impossible to register a litter as a fresh, extended semen breeding.

A good working relationship with a veterinarian experienced in reproduction is critical for success. Find a veterinarian that suits your needs by talking to local breeders, and then visit his or her clinic, and set up an appointment to discuss your goals. Please be frank in your discussions and don't be afraid to discuss cost. Choose a veterinarian with whom you feel comfortable, that you can talk to, and is willing to listen and educate you. Many veterinarians perform surgical insemination but fewer perform transcervical insemination. Be sure to treat the veterinarian as a member of your team, and remember that your veterinarian wants to be successful as much as you do.

There are a number of companies providing semen extender and shipping boxes. The most common are: Camelot Farms (www.camelotfarms.com), CLONE (www.cloneusa.com), ICSB (www.icsbK9.com), Minitube (www.minitube.com), and Synbiotics (www.synbiotics.com).

Remember, it's all about the timing. Chilled semen has been somewhat compromised through the cooling process, and the life span of the sperm may be shortened to 24 to 72 hours maximum in some cases, so OVT is very important. It is important to remember that the critical events that control the optimum time to breed occur 2 to 6 days prior to breeding. This gives us time to collect and ship the semen well in advance of the fertile period of the bitch.

Always remember Murphy's Law – if it can go wrong, it will. Here are a few common problems breeders encounter:

- Shipping problems – lost semen or weather delays
- Lab error
- Sampling handling error
- Veterinarian not available
- Need to breed on weekend
- Need to breed on a Monday
- Male not available
- Cannot collect male
- Acute infertility in the male (prostatitis, overheating)
- Kits not available when and where you need them

Even considering all of these potential problems, chilled semen does have it's advantages. It is more flexible because it generally lives longer than frozen semen. The life span depends on the fertility of the male, the extender used, and how it is handled or shipped. It can be inseminated either by vaginal, transcervical, or surgical insemination. The cost of shipping and collection is less than frozen semen and it can be just as successful as natural breeding.

So do your homework and make the best decision for you, your dogs, and in your circumstances.

Considerations for the Use of Frozen Semen

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We pointed out the importance of planning with chilled semen, but it is even more important with the use of frozen semen. However, some things are easier, and we will discuss and compare what you should consider.

In most cases, the semen has already been collected, frozen, and stored. With this, you have a fertility report, and a post-thaw evaluation. Armed with this information, you know how fertile the male dog is with this extender and freezing technique. It is important to remember that the only way to know if frozen semen is truly fertile is to obtain a pregnancy with it. The motility of the semen is not always a true gauge of it's fertility, as the freezing process may damage the DNA in the sperm head and while this sperm may be motile, it may not be capable of normal fertilization. However, having the freezing report in hand will help you decide what would be the best method of inseminating your bitch.

Once the decision is made that you are going to use frozen semen, you can have it shipped to a local reproduction facility that has storage facilities. Frozen semen requires specialized storage facilities with large liquid nitrogen tanks. Liquid nitrogen is a biohazard, but with care is it not dangerous. It is delivered to the veterinary clinic by the same companies that manage our oxygen supplies, so accessibility, management and maintenance are not big issues. Since frozen semen requires specialized storage facilities it is more expensive. However, the added benefit of having the semen at the clinic waiting for the bitch to ovulate allows you accessibility and removes some of the disadvantages of chilled semen involving availability. Now the semen is available no matter when you need it – whether it be a weekend, a Monday, or a holiday.

Frozen semen is more fragile due to the rigors of the freezing process itself and so it generally does not live as long nor is it as motile as chilled or fresh semen after it is thawed. Remember that the more that we manipulate the semen, the more it is compromised. Frozen semen is stored in media that protects it and gives it nutrition in its frozen state at -196°C (-320°C). This sustains the life of the sperm but may also damage the cell wall of the sperm during the freezing and thawing processes, no matter how careful we are or what system is used. Freezing preserves the semen for the foreseeable future, but it still depletes the energy stores of the semen, affecting its live: dead ratio and its motility. Different

extenders or media and freezing techniques will work better with different males, adding or detracting from the viability of the semen after it is thawed. There may also be some defects in the sperm cells, such as proximal droplets or acrosome defects, that can damage the cells during the freezing process and thereby compromise their viability.

Frozen semen can be just as successful as all the other types of breeding, but accurate ovulation timing (OVT) is critical to its success. Ovulation timing is necessary to determine the best time to breed. Ovulation timing is both an art and a science. All the resources at our fingertips should be used. The more information we have in our database, the more accurate we can be. The use of vaginal smears, vaginal speculum exams, evaluation of the external genitalia and behavior, as well progesterone and luteinizing hormone (LH) concentrations are beneficial.

Progesterone testing is performed by your veterinarian and needs to be quantitative and not qualitative. This means you need a lab to run the serum sample to obtain a numerical result and not just evaluate a color change on an in-house test. We need an exact number to accurately time the cycle. Ovulation timing generally needs to be started on the 6^{th} day of the cycle, and is then repeated every other day or daily until ovulation is confirmed. Each veterinarian will have his/her own protocol for sampling days. Samples need to be placed in red top blood tubes and not the serum separator tubes used by so many veterinarians for standard blood samples. Samples need to be reported back the same day or, at the latest, the next day so we can make informed decisions.

Luteinizing Hormone (LH) testing can be done accurately in the veterinary clinic and adds to the accuracy of the timing of the insemination. Serum samples should be collected and stored in red top tubes daily, starting at the same time as the progesterone testing. The samples are not run daily but rather the serum is frozen and stored for evaluation later in the cycle. The LH rise is very short and can be missed if samples are not obtained daily. Once you realize the day of progesterone rise, you can remove the stored serum from the freezer, and test for the LH surge (which is the triggering mechanism for ovulation), thus confirming the correct insemination date.

There are only two choices of insemination technique for the successful use frozen semen – transcervical or surgical.

Transcervical insemination requires specialized equipment to include either a cystoscope (endoscope) for visual insemination or the Norwegian pipette for blind insemination. Using the endoscope your veterinarian can visualize and cannulate the cervix allowing the semen to pass directly into the uterus. Remember, frozen semen does not have the energy stores of other semen, so the closer we get it to its target, the more successful we can be. Other distinct advantages of TCI include the fact it can be performed multiple times in one cycle and it does not generally require any sedation. TCI can also be used before or after a surgical insemination.

Surgical insemination is the author's preference. It is a relatively simple procedure, and is very safe. With normal safeguards such as pulse oximeters, EKG, and short acting gas anesthetics, there are few risks. It allows us to visualize and manipulate the uterus, and place the semen directly into the uterus and divide it equally into both horns.

While some people advocate the use of frozen semen vaginally, this requires the use of multiple inseminations and multiple breeding doses for each insemination, which wastes semen. Since frozen semen is packaged with the concept that it will be placed directly into the uterus, success rates and litter size with vaginal deposition will be markedly reduced compared to either surgical insemination or TCI.

Expense can be an issue since most aspects of frozen semen have added cost. Collection costs are more than chilled, storage costs are more, and of course shipping of the large shipping dewars costs more. Some owners want insurance on their stored semen, and it is getting more available.

How do you decide between frozen and chilled semen? First one should ask, what is available? The answer to that simple question may dictate what one does. Remember that both can be successful if one does his/her homework and remembers to ask the proper questions. If all else is the same, and I have a choice of chilled semen from an older dog or frozen semen from a younger male, give me the frozen semen, please. While if the choice is chilled or frozen from a young fertile male, chilled semen will likely be preferred, if the dog will be available when needed.

BREEDING OPTIONS IN THE BITCH

Rebecca Kestle, DVM

The goal of responsible dog breeders is to produce healthy puppies that adhere to specific breed standards and that can fulfill the jobs they are bred to do. With the advances in artificial insemination techniques that have occurred in the last 15 years, breeders have the option of choosing stud dogs from all over the world. That makes choosing the best brood bitch invaluable to a breeder, and knowing the options of breeding the bitch can help one achieve the best outcome.

Fertility in the bitch peaks when she reaches middle age (4 – 5 years) and declines thereafter. This allows breeders enough time to follow the guidelines of their breed clubs for pre-breeding genetic screening before breeding a bitch for the first time. Many breed clubs recommend waiting until bitches are at least two years old of age so that OFA X-rays, eye certifications, and thyroid testing can be done before the bitch is bred. Other breeds have even more stringent testing such as DNA markers for a variety of diseases. It is up to reputable breeders to maintain the quality of their brood bitches. Once the prescribed genetic testing has been performed, breeders must decide which insemination technique will be the best for the bitch depending on the type of semen to be utilized.
The bitch should be examined by a veterinarian who will take a thorough history, check for vaginal strictures, and perform a complete physical exam. A Brucellosis test is recommended since this disease is a contagious, potentially zoonotic (spread to humans), life threatening bacterial disease that can be transmitted via breeding or by coming into contact with infected material such as aborted feti, contaminated uterine secretions, semen or urine.

Guarded, cranial vaginal cultures are recommended on any bitch with a history of fertility problems. The culture is usually obtained on day two to three after bleeding begins and is sent for isolation of aerobic/anaerobic bacteria and Mycoplasma organisms. Many bacterial organisms, and even Mycoplasma, can be normal in the vaginal tract of bitches, but they can also cause infertility if they overgrow the normal bacterial flora of the vagina and are not treated. The veterinarian will start the bitch on the appropriate antibiotic if necessary. For bitches that do not conceive and have grown Mycoplasma on vaginal culture, it is recommended that they undergo treatment with doxycycline for four to eight weeks in between their heat cycles.

OVULATION TIMING

Ovulation timing is of the utmost importance, especially if you are using any type of processed semen, such as fresh chilled or frozen. The hormone that induces ovulation in the bitch is luteinizing hormone (LH). Testing for LH can be

done using an in-house kit, ICG Status-LH[1]. LH testing must be done daily to catch the LH surge since it may only last 12 – 24 hours. Even with LH testing, it is recommended to confirm ovulation with progesterone assays. Progesterone testing is readily available in most cities in the United States. Different types of progesterone assays are available. In-house kits identify ranges of progesterone, and must be run daily to counter the inaccuracy of the method. Commercial laboratories either use radio immunoassay (RIA), chemiluminescence (CLI), or enzyme linked fluorescent assays (ELFA). Some practices have in-house numerical progesterone machines (i.e. miniVIDAS or immulite machine) and can run progesterone samples in about an hour. Each veterinarian will have his or her own protocol as to when to breed bitches based on the type of breeding and their experiences.

Progesterone begins its normal rise at the time of the LH surge that stimulates ovulation. Serum progesterone concentrations are about 2 ng/ml on the day of the LH surge, and 4 -10 ng/ml on the day of ovulation. With each different type of assay the actual numerical value may differ, so be careful in memorizing a "magic" number. The eggs of the bitch are not ready to be fertilized at the time of ovulation. They must continue to mature, and it takes about two days before they are ready to be fertilized. The optimal days for breeding will be determined based on the day of ovulation and the type of breeding/insemination chosen.

NATURAL BREEDING

The vast majority of canine litters are produced by natural matings. Natural breeding is best used for young dogs and bitches that are thought to have good fertility. There is nothing wrong with presenting the bitch to the stud dog at about the time of ovulation and breeding the dogs every other day while she will stand and the stud has interest. It is best to bring the female to the stud dog and have supervised breedings so no fighting or injury occur. In young or inexperienced males, assistance may be required. Semen is not generally evaluated with a natural breeding, so litter size can be used as a potential indicator of semen quality. It must be remembered that small litter size may be due to sub fertility of either the male or female or a combination of both, so small litter size is not a direct indicator of poor semen quality, but rather an indicator that further workup of both male and female are required. With breeds that may require a Caesarian section, it is very important to determine the day of ovulation to help determine the timing of the surgery.

VAGINAL ARTIFICIAL INSEMINATION

The utilization of artificial insemination (AI) has been dramatically increasing over the past few years. Fresh AI offers the advantage of being able to evaluate the semen prior to insemination. The semen is collected with minimal prostatic fluid. An extender can be added if there is any decrease in sperm quality, or an alternative method of insemination may be chosen. An insemination pipette is gently inserted into the vagina with the bitches' hindquarters being elevated for at least five minutes. There is some evidence that it may not be necessary to elevate the hindquarters after vaginal AI to obtain normal pregnancy rates and

[1] Synbiotics, Kansas City, MO

litter size. After injection of the semen using a syringe, light feathering of the vagina with a gloved finger is helpful in simulating the action of the copulatory lock. Vaginal AI is usually performed either on days 2 and 4 (or 1 and 3) after ovulation or on day 4 and 6 (or 3 and 5) after the LH surge.

TRANSCERVICAL INSEMINATION (TCI)

Transcervical inseminations are normally performed with an endoscope to visualize the cervix. An alternative method of TCI uses a blind catheterization technique (Scandinavian catheter) with a rigid vaginal catheter. Either method of TCI requires specialized equipment and training. With endoscopic TCI, a camera on the end of the endoscope allows visualization of the cervix, to allow for passage of a catheter into the uterus, where semen is deposited directly. This increases the number of sperm that enter the uterus as opposed to the loss associated with deposition in the vagina. Use of TCI decreases the number of sperm needed to doses as low as 100 – 200 million normal, motile sperm. The uterus of the bitch can only hold about 2-3 milliliters (ml) of semen depending on the breed (1 – 1.5 ml in toy and small breeds). The semen must either be collected in fractions (pre-sperm, sperm and post-sperm fractions) saving only the sperm-rich fraction for insemination, or the semen must be concentrated by low speed centrifugation and then resuspended with extender.

TCI is normally performed on the unsedated, standing bitch. It is not as easy to perform on maiden bitches, toy breeds and some giant breeds due to either the size of the vaginal canal near the cervix or to the fact that the cervix may not relax adequately prior to whelping to allow passage of the catheter. Lack of visualization of the cervix may occur due to blood and secretions pooling at the front of the vagina. Additionally, the cervix may not be able to be moved to the proper angle to allow passage of the catheter. In rare cases, the vaginal canal of some giant breed bitches may be too long for the scope to reach the cervix. However, in most cases, in competent hands TCI is a most useful tool.

TCI is usually used with fresh or fresh extended semen. The benefits are that a smaller breeding dose is required and conception rates should be higher than with vaginal AI, especially when breeding bitches or dogs with fertility problems. TCI can be used with frozen semen, but surgical insemination is generally still preferred. The disadvantages of TCI include increased cost of the procedure and the need for extensive training and practice for reliable results. TCI is usually performed two times; once on day 2 and 4 (or 3 and 5) post-ovulation, or if performed once, then it is on days 3 or 4 post-ovulation.

SURGICAL INSEMINATION (SI)

Surgical inseminations are a routine procedure. During the procedure, the bitch is anesthetized and her abdomen clipped and prepared for surgery. An abdominal incision is made (much like a spay) and the uterus is located. Semen is injected directly into the uterus using a needle or catheter. The entire procedure takes less than 30 minutes. One major advantage of the surgical insemination is that the uterus can be visualized, palpated, and evaluated for pathology. It is not uncommon to find cysts in the uterus that can be gently ruptured prior to insemination to try to improve fertility. Other common pathologic findings include adhesions or thickened uterine walls. With surgical

inseminations, the bitch is usually bred one time, 3 – 4 days after ovulation.

Surgical inseminations are useful with any type of semen where semen quality may be compromised, with frozen or fresh chilled breedings, or on females with fertility problems. Similar to transcervical inseminations, the volume inseminated must be small. Frozen semen is packaged such that a breeding dose is in a volume of 1.5 – 2 ml.

The advantages of surgical insemination are the ability to inspect the uterus and ovaries, delivery of the entire breeding dose directly into the uterus, and minimizing contamination during breeding. SI leads to the highest rate of conception in many cases. The disadvantages include cost, risk of anesthesia, risk of abdominal infection (peritonitis), and risk of incisional infection. With a single SI, the cost of the surgery plus semen shipment is often equal to or less than that required for 2 TCI.

MULTIPLE SIRE LITTERS

The AKC allows breeders to use more than one stud dog during a breeding. This is especially useful if one is using semen from a sire that may be of questionable quality. Rather than losing the pregnancy due to failed conception, a second proven sire may be used to back up the sub-fertile sire. Generally speaking, the sub-fertile sire is inseminated first (on day 3 post-ovulation), using SI or TCI, and then the proven sire is inseminated 24 hours later (on day 4 post-ovulation), using TCI or vaginal AI (or natural breeding if a SI was not performed the day before). The use of 2 fertile sires will generally result in all the puppies being sired by only one of them, even if the semen from both sires is deposited at exactly the same time. DNA testing is required on the dam, both sires and all of the resulting puppies to determine parentage.

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Mastitis and Common Mammary Disorders of the Bitch

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Mastitis

Mastitis is inflammation of the mammary gland associated with infection. Mastitis can occur anytime during lactation including lactation at the end of false pregnancy. The most common bacteria isolated are coliforms, *staphylococcus sp*. and *streptococcus sp*. These bacteria are normal inhabitants of the intestines and skin of dogs.

Risk factors:

Bitches housed in dirty environments or unhygienic conditions, bitches in poor body condition, and bitches that are heavily parasitized or systemically ill are all predisposed. Puppies with long nails can predispose the bitch to infection due to trauma from the nails. In addition, galactostasis (see below) can predispose a bitch to mastitis.

Clinical signs:

Acute disease:

Typically, affected glands are reddened, firm and painful. Mastitis may involve only a portion of a gland, one whole gland or several glands. Milk from the affected glands can be normal in color (yellowish white if colostrum or white in normal lactation), greenish-yellow, brown or red and can have flakes or clots [1].

Abscessation and/or gangrene of the glands can be present in severe cases and can occur rapidly (this is an emergency). In these cases the glands may also appear dark or black in color. This type of disease can rapidly lead to a systemic infection, also known as sepsis.

If the bacterial infection in the glands is severe enough the bitch may have systemic signs of illness. The signs can include depression, neglect of pups, anorexia, lethargy, fever and/or shock.

Chronic or sub-clinical disease:

Failure of puppies to thrive can be a sign of sub-clinical disease. It is not known how common this condition is in dogs. It is important to note that mastitis does not appear to be the cause of “toxic milk syndrome” (see below) in puppies [2].

Diagnosis:

Microscopic examination of milk confirms the presence of pus instead of milk (milk may have a few white blood cells naturally but should not be made up of entirely them) and bacteria can be seen. Culture and sensitivity should be performed. CBC (complete blood count) may show signs of response to infection. Ultrasound may be helpful in diagnosis and in locating areas of abscessation [3].

Treatment:

Treatment is focused on management of the infection of the gland. The patient is started on broad spectrum antibiotics until culture and sensitivity results are available. The choice of antibiotic is important, as a drug that will enter and hopefully concentrate in the milk is needed. Many factors influence the choice of antibiotic including, lipid solubility, drug pH, integrity of the blood-milk barrier, and a drug's safety for puppies if they are nursing.

The gland should be hot packed or soaked in warm water, and milked out twice a day if the puppies are avoiding the mastitic glands. Puppies do not need to be weaned unless the bitch is septic, the gland is abscessed, the antibiotic needed is unsafe in neonates or the bitch is neglecting them. Continued nursing, will in fact, prevent engorgement.

The risk of septicemia to the puppies from the mother has not been well studied. One study found the same bacteria in both septicemic puppies and mastitis in the mother, though it is possible that the puppy introduced the bacteria into the teat causing disease in the mother and not the other way around [4]. In addition some antibiotics, although safe for the puppies, may inhibit the normal bacteria in the intestinal tract, causing diarrhea. The weights of puppies should be monitored daily to be certain they are gaining appropriately.

Systemically ill patients should be stabilized first, and then if abscessation or gangrene is present the infected and dead tissue should be surgically removed and drains placed. The entire gland may need to be removed in rapidly progressing cases, especially in the case of gangrenous mastitis.

Cooked white cabbage leaves applied to the glands then wrapped with vet wrap for two hours is anecdotally reported to help draw out fluids and infection. The author has not used this therapy and no studies have been done in dogs and cats however a few promising studies have been done in women [5]. Unpublished anecdotal reports suggest it may help.

Prevention:

Keep whelping areas very clean. The bedding in the box should be replaced 1-2 times a day and the box scrubbed and disinfected once a day. Toenails of puppies should be kept trimmed to avoid trauma to the gland. Glands should be checked by the owner daily as part of the routine post-partum care of the bitch and her puppies.

False pregnancy

Also called pseudocyesis or false lactation, false pregnancy is a normal occurrence in the bitch due to the natural fall in progesterone at the end of diestrus. It can also be observed if a bitch is spayed in diestrus or if progesterone drugs are withdrawn. It perhaps should have been called “false lactation” as this is why owners often present the dog.

Clinical signs:

If clinical signs are noted they typically occur 2 months after the end of estrus. Some bitches will have no clinical signs whereas others will gather stuffed animals, “nest”, and begin to lactate.

Diagnosis:

The diagnosis is based on clinical signs and a history of the bitch being in heat 2 months ago. A thyroid profile can be helpful as elevated TSH levels may increase prolactin secretion in a bitch with hypothyroidism.

Treatment:

Most bitches will resolve spontaneously in about 2 weeks. Bitches should be prevented from self stimulating the glands through licking, which will prolong the lactation. A child size T-shirt or ace wraps can be applied to keep her from licking. The glands should not be manipulated, hot or cold packed as this often prolongs lactation.

In bitches that do not resolve within 2-3 weeks medical therapy may be necessary. Withholding food and rationing water to ½ of normal intake for 24 hours can help her “dry up”. Cabergoline (dopamine agonist) is an expensive but effective treatment with few side effects. Bromocriptine is a similar drug that is less expensive than cabergoline but can have the unwanted side effects of vomiting and/or diarrhea. These side effects are minimized by starting at a low dose and increasing slowly over a few days and by administering with food. Mibolerone can be used but is an anabolic steroid hormone and also can have side effects, however they are less common and different than with bromocriptine. Progestogens (i.e. progesterone) should not be used as the signs will recur when the drug is withdrawn.

Pain medication can be given to very uncomfortable animals, but sedation with phenothiazine tranquilizers should be avoided as they can increase prolactin secretion leading to increased milk production. Recurrence is common as this is a normal process, but can be prevented with a spay once signs have resolved.

Agalactia / hypogalactia

Agalactia is the inability to produce milk and is rare in the bitch. It is sometimes seen in bitches on progesterone supplementation for suspected progesterone deficiency.

A more common scenario is inadequate milk production, hypogalactia. This may be seen in maiden or nervous bitches, bitches that whelp prematurely, bitches with small litters that are not being stimulated adequately, bitches with inadequate water or food intake, bitches in poor body condition or bitches that are heavily parasitized.

Treatment:

Oxytocin is unlikely to be effective in true agalactia as it only helps with milk letdown and not with milk production or gland development. It may help in cases of nervous or new mothers who are reluctant to nurse a litter especially when used as in combination with phenothiazine tranquilizers (these can stimulate prolactin secretion). Although injectable oxytocin has a very short half like, the combination allows the puppies to nurse and then stimulate normal oxytocin production by nursing. Domperidone (a dopamine antagonist) can be used to promote mammary development with few, if any, side effects (soft stool may develop). Metoclopramide, a drug normally used to enhance gastrointestinal motility and reduce vomiting, also indirectly increases prolactin levels. It may be used if domperidone is unavailable, but has the potential to cause some neurologic side effects (excitation, anxiety) especially when administered at higher dosages because it does cross the blood-brain barrier. If metaclopromide is used, the bitch's behavior should be carefully monitored. These medications may also be used in combination with oxytocin to stimulate milk letdown, especially in nervous bitches.

Galactostasis

This is the build up of milk in the mammary glands due to delayed passage of milk out of the teat ducts. It can be due to the normal weaning process, when there are no puppies to nurse or if puppies are removed abruptly.

Treatment:

Anti-inflamatory pain medications can be used to increase comfort and reduce inflammation. Engorged glands should not be milked out as this will only continue or increase milk production. Therapies that decrease milk production can be used as described above in the treatment for false pregnancy. Wrapping the glands may help to decrease milk production due to hormonal feedback to the brain and also keeps the bitch from self stimulating [6].

If decreased milk production is not desired because the puppies would be put back on the bitch in a short period of time, the glands should be regularly milked out by hand and medications should not be used unless mastitis develops.

Toxic milk syndrome

This diagnosis is often used when the cause of death of pups can not or is not determined. It is easy to “blame” the milk when puppies die unexpectedly, however, there are many causes of neonatal death and disease. It is important to perform diagnostic tests (necropsy, blood tests, cultures etc.) to determine the actual cause of death. Some of these puppies may in fact be dying of diseases that can be transmitted via the milk however, they may also be suffering from treatable or preventable diseases, such as herpes virus or hypothermia for example. This term is not discussed in modern human medicine and it is the author’s opinion that this diagnosis should no longer be used in veterinary medicine.

Mammary cancer

Mammary cancer is the most common cancer in female dogs. 50% of canine mammary tumors are benign (most commonly fibroadenoma) and 50% are malignant (most commonly adenocarcinoma). Adenocarcinoma commonly metastasizes to the regional lymph nodes and lungs. The caudal glands are most commonly affected.

Clinical Signs;

One or more lumps in the mammary glands of the intact or spayed bitch is a sign of mammary cancer. Rapid growth of a mass or the presence of a large mass more commonly indicate malignant disease than benign disease. In rare cases a condition called inflammatory mammary adenocarcinoma may present similarly to mastitis with red, painful glands and systemic disease [2].

Diagnosis:

Initial diagnosis is made by palpation of one or more masses in the mammary glands. Multiple masses are common. Fine needle aspirate or touch prep cytology of ulcerated masses can often give a preliminary diagnosis. However, a negative cytology does not mean that a tumor is not malignant since many mammary tumors do not readily shed cells making an accurate diagnosis difficult with cytology alone. Tissue should always be sent for histopathology (microscopic analysis) to confirm the diagnosis. Radiographs of the chest and an abdominal ultrasound to check for metastasis should be performed when malignancy is diagnosed.

Treatment:

Surgical removal of the masses along with spay is highly recommended but spaying may not be an option in valuable breeding animals. Even benign tumors can become quite large and uncomfortable, making them difficult to remove. Several surgical procedures have been recommended but there is no evidence that any individual procedure correlates with increased survival time. A more radical surgery, such as an unilateral mastectomy may be associated with decreased recurrence at the site. Unfortunately, studies have demonstrated that the type of surgery has no effect on the cancer free interval [7-8]. Total mastectomy (removal of all glands with or without the lymph nodes is rarely performed as there is not usually enough skin left to close the incision and only one paper has shown improved survival [9]. If a spay is performed at the same

time as surgery to remove a tumor, the spay should be done first to prevent seeding the abdomen with neoplastic (cancer) cells. Chemotherapy and radiation therapy are not well characterized in the dog although protocols do exist. Surgical procedures used are as follows:

- Lumpectomy – removal of mass only, with or without wide margins
- Simple mastectomy – removal of the entire gland containing the mass
- En bloc dissection – removal of the entire gland containing the mass and the regional LN and lymphatics
- Unilateral mastectomy – removal of the entire chain of glands with or without the regional lymph nodes

Prognosis:

The prognosis is very good for benign masses. Malignant masses <2cm have a fair to good prognosis after surgical removal. After surgical removal, dogs whose tumors were less than 3 cm in diameter had a significantly increased duration of survival, with a median of 22 months versus 14 months for dogs with tumors greater than 3 cm in diameter [10].

Prevention:

Dogs spayed before the first estrous cycle have 0.5% the risk of developing cancer when compared to intact dogs, dogs spayed between estrus 1 and 2 have 8% the risk, those spayed after 2 cycles have 26% risk. After the second cycle it is unclear what the exact benefit of spaying is on risk of mammary cancer, but it is believed that there is some reduction in incidence even with aged bitches. Pregnancy has no effect on the risk of developing mammary cancer. [11]. Exogenous progesterone administration (typically used for keeping a dog out of heat) can increase the risk. [11-12]

Mammary cysts

Mammary cysts, also called fibrocystic disease of the mammary gland or blue dome cysts, may have a hormonal basis. Is occasionally possible to aspirate clear to brown fluid from the mass. The major concern with this condition is making sure that the masses felt are cysts and not lumps. The best way to do this is by removing them or taking a tissue sample from them. Fine needle aspirate may also help but is not as good as biopsy. The ability of these cysts to develop into cancer is not known [13]

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Postpartum Problems in the Bitch

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What You May Expect in the Normal Bitch Following Whelping

It is considered normal for bitches to have vaginal discharge for up to 3 to 5 weeks after whelping. The discharge (called lochia), immediately postpartum, is very noticeable because of its green color due to the presence of uteroverdin (iron pigment) at the edges of the placental attachments. Unless there are complications, this should change to a reddish-brown to green mucoid discharge within 12 hours. Normal uterine involution and repair may occur for up to 16 weeks post-whelping. Bitches body temperature may be mildly increased (up to 103 degrees) postpartum, due to normal inflammation associated with whelping. Their temperature generally returns to normal (99 to 102) within 24 to 48 hours. If bitches have had a cesarean section, their temperature elevation may be elevated due to post-surgical inflammation. Elevations in temperature need to be monitored, and may indicate some pathology in the bitch. Mammary glands should be symmetrical and moderately firm with no palpable firm masses, redness or heat. Milk should be easily expressed from several openings at the end of each nipple. Normal colostrum may be deep yellow to light yellow in color and from thick to thin in consistency. Colostrum is only produced for the first 18 to 24 hours post-whelping. Normal milk may be white to grayish in color and is of watery consistency. Any changes from these normal observations may be indicative of problems and need to be assessed by your veterinarian.

Retained Placenta

Retained placenta is an extremely uncommon postpartum problem in the bitch. Detachment and passage of the placenta usually occurs with the birth of each puppy or within approximately 15 minutes of delivery. The most difficult aspect of this problem is accurately diagnosing it. Owners often attempt to count placentas as they are passed. With the confusion and excitement associated with observing each puppy's delivery, we often fail to see how quickly the dam may consume a placenta. True failure to expel a placenta is reported most commonly in toy breed dogs. Definitive diagnoses are almost impossible as the retained placentas degenerate, and are passed in the normal postpartum discharge. If the bitch has live puppies that are nursing, she is producing oxytocin which leads to uterine contractions and should allow for the normal expulsion of this tissue. Retained placenta(s) can lead to uterine infection (metritis), which can result in the bitch becoming quite ill (see below).

Metritis

Metritis is a serious condition and is often times confused with pyometra. Metritis generally refers to infection of the uterus after whelping when progesterone levels are low. We refer to pyometra when we discuss uterine infections that occur when the uterus is under the influence of progesterone.

Progesterone levels are elevated from the time of the LH surge, and remain elevated for approximately 65 days, in the pregnant bitch, before returning to a baseline. Acute infection of the endometrium (lining of the uterus) should be suspected if lethargy, anorexia, decreased lactation, fever, and odiferous vaginal discharge are noted. The bacterial infection is usually due to ascending infection from the lower genitourinary tract. This infection may be preceded by dystocia, retained fetuses or placentas, or from contaminated obstetrical manipulations. Rapid diagnosis of metritis is important for the bitch's health and her future reproductive capacity. Changes in blood work (biochemical changes) usually reflect septicemia (bacteria in the bloodstream), inflammatory reactions, and endotoxemia. This can be represented by either increased or decreased white blood count +/- anemia, increased or decreased protein levels, signs of dehydration, or elevations in kidney and liver enzymes. Vaginal cytology reveals a hemorrhagic to purulent (pus-like with white blood cells and bacteria) discharge. Abdominal ultrasonography may reveal retained placentas or fetuses, mummies, or a fluid distended and/or thickened uterus. Vaginal culture and antibiotic sensitivity testing should be done for both aerobic and anaerobic bacteria. Collection for the culture should be with a guarded culture swab and taken from the anterior or upper portion of the vagina as close to the cervical opening as possible.

Medical management should include intravenous fluids with appropriate electrolyte evaluation and supplementation, and broad-spectrum antibiotic administration. Ovariohysterectomy may be indicated depending on the bitch's condition and her response to medical management. Treatment with oxytocin for 3 to 5 days will help to evacuate the uterus of discharge. Use of prostaglandin F2-alpha (PGF2α), to evacuate the uterus, requires care and close observation since the infected uterus may be friable or damaged and could perforate or rupture with this medication. Additionally, the septic bitch may develop respiratory distress, a drop in blood pressure, or collapse with the use of PGF2α. Metritis can result in a chronic endometritis and can affect future fertility.

Uterine Prolapse

Uterine prolapse is a very uncommon occurrence in dogs as a complication of parturition. Prolapse is the protrusion of part or all of the uterine horns and body through the vulvar lips. The diagnosis is based on palpitation of a firm tubular mass, protruding from the vulva postpartum, and an inability to identify the uterus with abdominal ultrasonography. Replacement should be attempted as soon as possible, because the longer the tissue is exposed, the more likely that severe edema (swelling), tissue infection, and necrosis (tissue injury) will occur. The prolapsed uterine tissues are at risk for damage and infection as a result of exposure and contamination.

When the uterine tissue is healthy, repositioning in the abdomen may be attempted. However, the size of most bitches and swelling of the uterine tissue resulting from the diminished blood flow out of the prolapsed tissue usually prohibits manual replacement alone. Typically, a combination of manual external reduction combined with abdominal repositioning through a ventral midline incision is needed to replace a prolapse. Sterile lubricant is applied liberally to the exposed tissue while the animal is being stabilized and anesthetized to prevent

further trauma to the tissues. The prolapsed uterine horn(s) is flushed with sterile saline under pressure. Manitol, hypertonic saline, or dextrose solution can be used to reduce edema if necessary before attempting reduction. Once the uterus is replaced, care should be taken to fully evert the tips of both horns and then the animal should be given 1 to 2 units of oxytocin to cause uterine contraction and prevent re-prolapse. If the uterus remains in place for 24 hours, the risk of re-prolapse is unlikely because the cervix begins to close. If the tissue is damaged or necrotic, an ovariohysterectomy is recommended. In some cases, reduction is impossible due to extreme engorgement or necrosis of the prolapsed tissue. In these cases, the external segment can be amputated followed by ovariohysterectomy. The prognosis for future fertility and chance of reoccurrence are undefined.

Subinvolution of Placental Sites

During formation of the placenta, the cells from the developing embryo invade into the uterine wall. After the placentas detach post-whelping, the placental sites normally heal (involute) by sloughing these invading cells (syncytial trophoblast cells). In some cases, however, these cells continue to invade into the uterine wall, resulting in continued hemorrhage from the placental sites. This condition is termed subinvolution of the placental sites (SIPS).

The condition is clinically detected by the presence of serosanguineous (yellowish-red) to hemorrhagic vaginal discharge beyond 4-5 weeks postpartum. The normal uterus continues to involute and repair itself for a period of up to 16 weeks. The cause of SIPS is unknown, and generally infection is not present. Fertility is maintained and blood loss is minimal.

Treatment is generally not necessary, recovery is spontaneous and the symptoms are usually mild. On rare occasions, bleeding may be sufficiently heavy to result in significant anemia. When vaginal bleeding is copious other causes need to be investigated such as clotting disorders, trauma, neoplasia of the genitourinary tract, or normal proestrus. Diagnostics include vaginal cytology, vaginoscopy, coagulation testing, ultrasound, and radiographs (x-rays) to aid in determining the cause or source of bleeding. Definitive diagnosis requires biopsy of the placental sites, however, this is rarely necessary. Vaginal cytology is often diagnostic for SIPS if syncytial trophoblast cells are visible more than 4 weeks after delivery. Cytology in dogs with SIPS contain only a few white blood cells. Ultrasonography can also be used to diagnose the condition when placental sites are still readily visible beyond 4 weeks postpartum. On rare occasions, bitches may hemorrhage significantly and require blood transfusions or an ovariohysterectomy as a life-saving measure.

Mastitis

Mastitis is an acute or chronic infection of the mammary gland involving one or multiple mammary glands. The most common organisms involved are those of the skin. As puppies nurse and pull, or bite the teats, environmental bacteria can gain entry to the skin and mammary glands. Infection may also be from hematogenous (from the bloodstream) sources as well. One or more glands may be affected and are red, firm, warm, and painful to the touch. The bitch may exhibit varying degrees of pain, be neglectful of the puppies, become lethargic,

febrile, have decreased appetite, and not allow proper nursing by the puppies. Milk from the affected glands is often discolored (red, brown, or green) due to the presence of red and white blood cells and is generally thicker than normal milk. Abscesses may develop and be seen and palpated as bulging, firm spots over which the skin is discolored and may rupture.

Milk from these glands will contain white blood cells and bacteria and the secretions should be submitted for culture and be evaluated by cytology. Antibiotic therapy should be started based on cytology results and adjusted accordingly to the culture if necessary. Penicillin or cephalosporin's are a good choice for empirical treatment until culture results are returned. Using hot compresses or whirlpool therapy of the affected gland(s) and manual gentle stripping of milk out of the affected gland(s) is helpful.

There is no evidence that nursing from the affected glands is problematic for the puppies, but they will tend to avoid glands from which it is difficult to obtain milk. If abscessation is present or culture results indicate antibiotics that are unsafe for the nursing puppies, it may be necessary to wean.

Severe abscessation and necrosis may warrant mastectomy and aggressive wound management. Occasionally, bitches will develop mastitis on subsequent lactations. This may be due to some anatomic feature of their mammary glands that allows for bacterial invasion. Antiprolactin therapy (cabergoline or bromocriptine given orally twice daily) may be indicated in severe cases to reduce lactation. Early detection and treatment is optimal, rather than prophylactic antibiotics, which tend to favor resistant organisms.

Agalactia

Agalactia is defined as a failure to produce milk. While uncommon, primary agalactia is a lack of mammary development during gestation, which, results in inadequate milk production. This is a commonly recognized adverse effect of progesterone supplementation during pregnancy. Secondary agalactia is more common, and is a lack of milk available due to a failure of milk letdown into the mammary chain. Mammary development is present but milk cannot be readily expressed through the teat sphincter. Agalactia can occur secondary to premature parturition, malnutrition, severe stress, metritis, mastitis, or other illness.

Once noted, treatment includes providing supplementation to the puppies while continuing to allow suckling, which promotes milk ejection. It is important to provide optimal levels of nutrition and adequate water to the dam and resolve any underlying disease. If detected early, milk letdown can often be induced pharmacologically. Mini doses of oxytocin (0.25 to 1 units per injection) are given subcutaneously every 2 hours. Puppies should be placed on the bitch immediately following oxytocin administration to promote milk letdown.

Metoclopramide orally, subcutaneously, or intravenously, can be given every 12 hours (dopamine antagonist) to promote milk production. Metoclopramide may have unwanted neurological side effects after multiple doses. Alternatively, domperidone (another dopamine antagonist) can be given orally to increase milk production with minimal to no side effects. Therapy with

either medication is usually rewarding within 24 hours. If acceptable results are not achieved, hand rearing of the puppies is necessary. Bitches with poor milk production resulting from low concentrations of either prolactin or oxytocin may exhibit poor mothering behavior. A bitch that fails to produce milk during one pregnancy is likely to have a similar problem on subsequent pregnancies and should be considered for removal from the breeding program.

Galactostasis (Stagnant Milk)

Galactostasis (build up of milk) can cause engorgement and edema of the mammary glands with associated discomfort. This makes further nursing less likely due to unwillingness to allow the puppies to nurse and the problem becomes self-perpetuating. Galactostasis may occur secondary to inverted or imperforated teats, litter loss, failure to rotate nursing puppies, small litter size or occasionally from pseudocyesis (false pregnancy). This accumulation of milk may predispose the bitch to mastitis. In bitches who have lost their litter or have false pregnancy, cabergoline or bromocriptine orally twice daily for 2 to 4 days may be helpful.

Eclampsia

Eclampsia or puerperal tetany is a result of low concentrations of calcium in the body. This should not be confused with preeclampsia in women, a syndrome of high blood pressure and protein loss that occurs during late pregnancy. In dogs, this is usually noted during the first 4 weeks (at peak lactation) postpartum, but can occur in the last few weeks of gestation. Eclampsia can be life-threatening and is predisposed by improper prenatal nutrition, inappropriate calcium supplementation, and heavy lactation demands. This is most common in small breed dogs nursing large litters, and is more likely if the ratio of body weight to litter size is small. Excessive prenatal calcium supplementation can interfere with the physiologic mechanisms to mobilize adequate calcium stores and utilize dietary calcium sources. It is best to feed a balanced growth or puppy formula commercial diet without additional vitamins or mineral supplementation during the second half of gestation and throughout lactation. Supplementation with cottage cheese or other dairy products should be avoided as it may disrupt normal calcium-phosphorus-magnesium balance in the diet.

Although the onset of clinical signs of eclampsia is most common at peak lactation, hypocalcaemia may develop during late pregnancy or at whelping. Initial clinical symptoms may include behavioral changes, salivation, stiffness or limb pain, ataxia, hyperthermia, and rapid heart rate. Bitches may be neglectful of the puppies, restless, or exhibit scratching at the face. This may be followed by a wobbly gait, dilated pupils, disorientation, and tremors. Symptoms may progress to the development of tonic-clonic muscle contractions or seizures.

Immediate medical intervention should be instituted with slow intravenous infusion of 10% calcium gluconate given to effect. Close cardiac monitoring (by use of electrocardiogram) for bradycardia (slowing of the heart rate) and arrhythmias (abnormal heart rhythm) is required. Uncontrolled seizures may lead to cerebral (brain) edema. Barbiturates or diazepam (1 to 5mg intravenously) may be indicated. Mannitol may be indicated for cerebral inflammation and

swelling. Corticosteroids are undesirable because they may further decrease calcium levels. Blood glucose levels should be monitored and treated if they fall. Hyperthermia from seizure activity should be treated if necessary. Once neurological signs are controlled a subcutaneous infusion of equal volumes of calcium gluconate and 0.9% saline solution is given repeatedly every 6 to 8 hours until the dam is stable enough to take oral supplementation.

It may be beneficial to remove the puppies from the bitch for 12 to 24 hours. If response to therapy is prompt, nursing may be gradually reinstituted until the puppies can be safely weaned. If clinical signs recur once the puppies resume nursing, they must be removed and hand-fed or weaned. Eclampsia may recur at a subsequent lactation. It may be prevented by feeding a well-balanced diet during pregnancy, without calcium supplementation. In bitches with a history of recurrent eclampsia, calcium carbonate (500 to 4000 mg/dam/day divided) may be given throughout lactation. Each 500 mg calcium carbonate tablet (TUMS, regular strength) supplies 200mg of calcium. It is better to wait to supplement calcium orally until at or after whelping, rather than during pregnancy as over supplementation during pregnancy may result in uterine inertia (failure of the uterine muscle to contract adequately during labor).

Postpartum Behavior

Dog owners often seek professional advice concerning what is normal behavior for bitches after whelping and for the treatment of abnormal or undesirable aspects of maternal behavior. Maternal behavior is so important for the survival of offspring that evolutionary forces have programmed the brain circuitry to aid with puppy survival. Due to our involvement during delivery, cleaning and resuscitation of newborns, supplemental bottle or tube feeding, and assistance in weaning onto solid food, we have likely facilitated survival and reproduction of some mothers with defects in their maternal programming. Some dogs exhibit complete and effective maternal behavior while others would have few, if any, surviving offspring without our assistance.

With major physiologic changes occurring at the time of birth, along with the overwhelming presence of demanding puppies, it is somewhat surprising that females remain as calm as they do during this post-whelping period. It has been found that stressful physical stimuli produce a smaller adrenocortical response in lactating females. Rather than responding to threatening stimuli with excitement, the dams are induced to remain calm and continue to care for their young. In a wild setting, this may put the mother’s own safety in jeopardy, but the mechanism prevents disruption of her care at this critical time.

If the dam becomes excessively nervous after whelping, this may lead to her attacking her own offspring. Killing and consuming any part of the dead newborn is considered cannibalism. This has been proven in other species to adjust the litter size in accordance with environmental or nutritional conditions (low protein diets). So as wild animals, this may be regarded as a normal aspect of maternal behavior. Cannibalism may also be considered to be related to lack of maternal experience, immaturity of the dam, illness of the newborns, or environmental disturbances. For example, a sickly puppy may harbor disease

organisms that could affect the remainder of the litter. Bitches may often sense physical abnormalities in the young that trigger the attack. This may include low body temperature, lack of movement, or some other reason not obvious to us. Her rejection may include cannibalizing the young, shoving it out of the whelping box, burying it, or hiding it from the remaining litter. In nature, this would minimize the attraction of predators to the other young and aids the bitch in avoiding wasting energy resources needed to care for these unhealthy puppies.

Overzealous cleaning of the newborn may lead to chewing into the abdominal cavity while she is trying to shorten the umbilical cord. Hormonal factors may incite this response as well. Placentas produce appreciable amount of progesterone during pregnancy, but this level falls abruptly at parturition with the detachment and expulsion of the placenta(s). Progesterone has a calming effect on bitches so its declining levels may precipitate irritability and aggression toward her young. Some bitches may excessively lick and carry their puppies around. Using a DAP plug-in (Dog Appeasing Pheromone) device may be helpful in calming the mother.

In rats, it has been proven that small litter size may not provide enough stimulation to the mother to maintain satisfactory maternal behavior to her young. This may apply to dogs as well in that a bitch with a singleton may not be able to leave the puppy alone so it can rest. Very large litter size may also be stressful to the dam. These bitches may seem anxious, vocalize and have difficulty settling down because they are obsessing over puppies crawling away from the group or due to the number of puppies for which them must care. Maternal indifference may also be a result of domestication and our continued involvement in the entire whelping and raising of our puppies.

Another important concern that is believed to create aggressive behavior toward people or puppies is a low calcium level. Calcium is needed for oxytocin uptake, which is needed for normal maternal bonding and imprinting on the young. Bitches with low calcium levels will often get glassy-eyed, stare and growl at pups, try to hide in small places or closets, or be disruptive and continually move puppies around. Often these bitches do not respond normally to their owners either. When monitoring calcium levels, one must monitor ionized calcium levels. Total calcium levels have been shown to be normal in association with calcium-responsive maternal aggression in Bull Terriers. Bitches may dramatically improve within 30 to 45 minutes of calcium administration.

Hyperexcitement, failure to allow nursing, or other behavior may also be seen after Cesarean section. This may be secondary to pain response or from lack of recognition of the offspring. Maiden bitches that have never whelped before may not react positively toward their offspring when presented with their litter after surgical recovery. It may take up to 72 hours post-whelping for some bitches to exhibit normal maternal behavior. Close observation of the bitch and puppies during this time period is critical. When bitches are uncomfortable or in pain it is common to see unusual behavior. Proper nutrition, environmental conditions (temperature and quiet surroundings) and close human observation or intervention are necessary for a successful puppy raising experience.

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Misconceptions about Canine Nutrition

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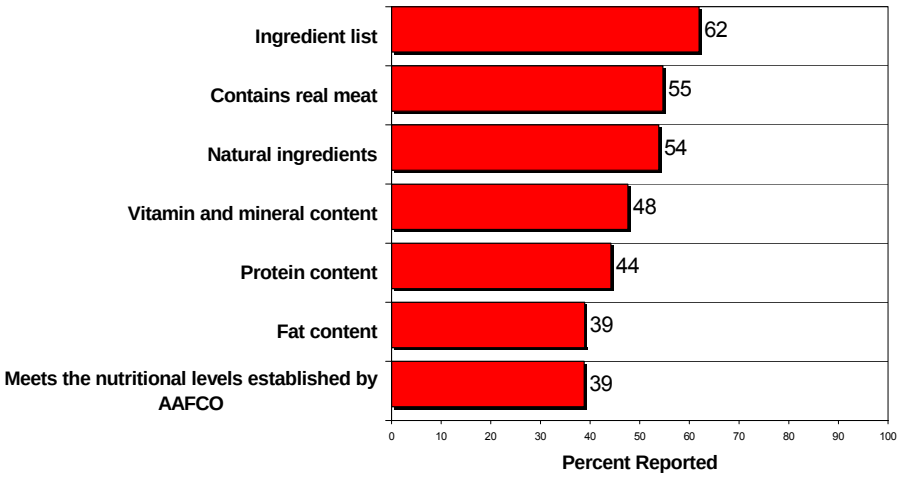
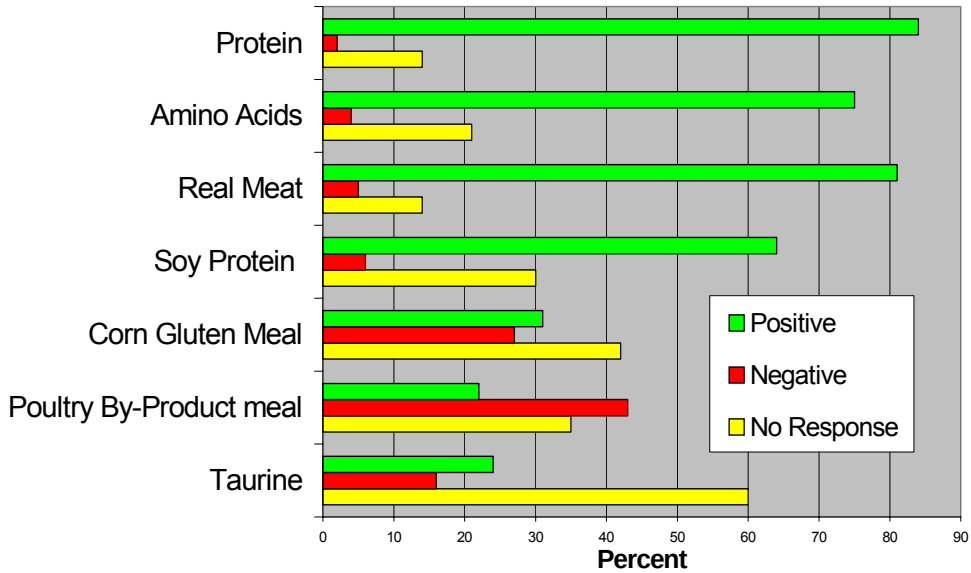
Nestle Purina Petcare

WHAT DO PET OWNERS LOOK AT WHEN CHOOSING A PET FOOD?



Seventy five percent of pet owners read/compare nutritional labels and ingredient lists before purchasing pet foods. When Pet Owners compare packages, what should they be looking for and how do they interpret what they see?



MYTHS

1. Commercial pet food products are made of filler ingredients like corn.

Actually, what most pet owners are interpreting as “filler” is the protein source known as corn gluten meal. Corn gluten meal is the dried residue from corn after the removal of the larger part of starch and germ, and the separation of the bran by either the process employed in the wet milling manufacture of corn starch or syrup, or by enzymatic treatment of the endosperm. Corn gluten meal, which is 60-64% protein, can hardly be described as “filler”. It is high in sulfur containing amino acids. Many pet owners think that corn is a common cause of food allergy in the dog. However, in one study of 200 confirmed cases of food allergy, 3 were corn and 3 were rice. (Small Animal Clinical Nutrition, 2002)

2. Dry foods prevent dental disease better than canned foods.

While the mechanical action of some dry foods works to help prevent the buildup of plaque in some dogs, dry food itself does not prevent dental disease in dogs. In order for a diet to prevent dental disease, it must be formulated with specific ingredients that inhibit bacterial growth and promote abrasive action on the teeth. Some dogs are prone to poor dental hygiene because of anatomy (bull dogs), or genetics, or simply because they do not chew their food.

3. Neutering makes pets gain weight and become obese.

This is the one “myth” that is partially true. Neutering actually decreases the metabolic rate of the animal by almost 40%; therefore, food intake must be decreased accordingly. The reason that neutered pets gain weight is due to the fact that pet owners continue to feed the same amount of food they fed prior to the neuter. This can be remedied by reducing caloric intake or increasing caloric use by increasing the pet’s level of exercise at the time of the neuter.

4. A dog's digestive system is not able to fully digest and utilize grains.

A dog's digestive tract is much less specialized for digesting grains, (in the form of carbohydrates) in their raw, unprocessed form than humans. However, dogs are not true carnivores and can digest and utilize the starch from grain that has been converted by the cooking process. Carbohydrates must be processed in order to be digested by the dog. This is either achieved by finely grinding, pureeing or mincing, or gentle cooking or steaming. Undercooked starches are poorly digestible and properly cooked starches have excellent digestibility. After heat and moisture blast apart granules, enzymes in intestine can work to chop up the starches and create monosaccharides for easier absorption. Digestibility depends on quality and type of grain used: rice (72%) is for example more digestible than wheat (60%) or corn (54%).

5. Pets should be fed bones and raw foods as they ate in the wild because dogs are carnivores.

Dogs are opportunistic, carnivorous scavengers, not true carnivores like cats. One of the drawbacks to feeding raw foods is bacterial contamination, particularly Salmonella. A recent veterinary journal article cultured live Salmonella from nine out of ten dogs fed a BARF diet. While the dogs appeared healthy, the concern was that the Salmonella could contaminate children or immunocompromised individuals in the household. Additionally, immune compromised dogs (neonates, geriatrics, animals with cancer, late pregnant and lactating bitches) may be more predisposed to illness if these bacteria enter the circulation through the gut wall. The key to a healthy dog is a diet that is balanced regardless of whether it is raw or cooked.

6. Preservatives cause cancer and other diseases.

No preservatives have been implicated as a cause of cancer or infertility even though this is the strongest myth present in the general population. Preservatives are added to pet foods to prevent the growth of molds and bacteria, because in fact, many pet food deaths have been associated with aflatoxins and other by-products of mold growth. Many pet food manufacturers use natural antioxidants such as Vitamin C and Vitamin E if you are concerned with chemical preservatives.

7. Commercial pet foods are made from meat gathered from road kill and diseased pet animals

Raw materials use to make pet food come directly from slaughtered animals for human consumption:

"about 50% of beef cattle tissue, 44% of swine, and 30% of poultry tissues are not destined for retail trade. Thus, 129 million pounds of animal tissues are created daily, or 47.1 billion pounds per year. This annual amount would fill semi-trailers end to end over a four-lane highway stretched from New York City to Los Angeles."

31 samples of pet foods from variety of manufacturers tested and NONE of the samples were positive for pet DNA--AJVR, Jan 2004

Reading a Pet Food Label

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Nestle Purina PetCare

What is Required By Law?

AAFCO is the Association of American Feed Control Officials. It is the primary policing body for pet food manufacturers. According to AAFCO, pet food labels must "by law" include several parameters. The principal display panel (PDP) is the front panel which includes: the ingredient statement which must have ingredients in descending order of inclusion. For example, if the food is Lamb and Rice, and rice is the primary ingredient it will be listed first. If lamb is the primary ingredient, it will be listed first. It is important to look at the ingredient list because product names may be misleading (see below); however, the guaranteed analysis (GA) is really the most important part of the label. Product type and nutritional adequacy pertains to whether this is adult dog food or whether it is approved for all life stages which includes puppies and pregnant or lactating bitches. Obviously, foods that are approved for all life stages will have increased amounts of certain nutrients required for growth and reproduction. Nutritional adequacy is determined by animal feeding protocols. "Formulated to meet" means that the product is complete and balanced and is comparable to a product which was fed in animal trials. If stated "for all life stages" then it can be fed to pregnant, lactating and growing animals, while if stated "for maintenance" then it cannot be fed to them.

Feeding directions must be included in the PDP. While in the past, most pet food manufacturers have included feeding directions according to body weight, recently some pet food companies have changed recommendations to "feed according to optimal body condition". Body condition score is a better indicator of adequate nutrition without predisposing to obesity.

Obviously the brand name of the product is required for identification, as is the name and address of the food manufacturer. While this may not seem important, it can become important particularly when there is a pet food recall. The GA is the most important part of the label required by law. This is where the consumer will determine if the food is appropriate for their dog. The GA is a nutritional assessment of the food that requires truthful disclosure of the minimum amount of protein, fat and fiber and the maximum amount of water or moisture in the product. In products which claim "light or lean", the maximum amount of fat will be included.

What Is Policed?

Claims on pet food are policed by AAFCO. Look for "proven" claims because these require that the pet food company has scientific data to back the claims. If the company states on the label that the food decreases the incidence

of arthritis in dogs, they have to prove with clinical trials and scientific evidence that this is in fact true. The FDA will investigate claims that are not supported by scientific evidence, if advertised as "proven". If the claim is that the food "helps to reduce arthritis in dogs" this is a softer claim and therefore, less or no scientific data is needed. Be cautious of terms like "based on literature" to support claims of superior nutrition. This does not prove anything, because the foods used in the "literature" studies may not be the same or the conditions studied may not apply to your dog's health.

Product Names

Specific rules apply to pet food product advertising. For a product to boast "All" or 100% it must contain 1 ingredient + vitamins and minerals. For example, if a pet food is called "All lamb" it must by law contain only lamb (no rice, no vegetables and no other meat by-products). In contrast, the 95% rule states that at least 95% of 1 ingredient + vitamins and minerals. The example would be a product such as Mighty Dog Beef which is one of the few products that fulfills this criteria by law. The 25% rule states that at least 25% of ingredients listed must equal 25% of product. This nomenclature is usually associated with names like dinner, platter, entrée, formula, or recipe. Most of the products on the market (particularly dry formulations such as Lamb & Rice) will fit into this category. Finally in the 3% rule, at least 3% of ingredient listed must equal 3% of the product. This would include products that state for example, "with filet mignon". Clearly no pet food manufacturer will put more than 3% filet mignon in a product because it would be too expensive to sell.

A Few Definitions

1. Digestibility-The amount of food/nutrient that is absorbed across the gut wall
2. Bioavailability- The amount of nutrient that is available for further use after crossing the gut wall into the blood stream
3. Meat- Muscle, fat, some skin; no bones or organs
4. Chicken- muscle, skin w/ or w/o bone; no organs, heads, feet, or feathers
5. Meat Meal- rendered (cooked) meat w/o hoof, horn, hide or big bones
6. Meat & Bone Meal- rendered meat & accompanying bone w/o hoof, horn, or hide
7. Chicken Meal-rendered muscle, skin w/ or w/o bone; no organs, heads, feet, or feathers
8. Chicken By Product Meal- muscle, skin, w/ or w/o bone, contains organs; may contain heads, feet

Guaranteed Analysis vs As Fed vs Dry Matter

Guaranteed analysis includes the minimum percent protein and fat and the maximum amount of moisture or fat (if lean/light) in a formulation. While the term “As Fed” is often used by consumers to judge products, it should NOT be used to compare products. Instead the GA should be used. As fed implies that this is an “example” of what you would find in a bag or can of food if you picked it off the grocery/sales shelf—but it’s not! As fed values are influenced by the number of samples used to create the average, the water content of the food, and the ingredient lot (fat, protein). The “As Fed” analysis will always be higher in protein and fat than the GA because this is a random sample used to “prove” that the product meets the minimum for protein and fat. Companies will always err on the side of adding more of these ingredients in order to meet the minimum in the GA on each batch. Another method of listing the nutritional content of the diet is to use “Dry matter basis” or DMB. This method is used to compare wet and dry foods because canned foods contain 75-78% water and dry food contain only 10-12% water. In order to compare protein content for example in a canned vs a dry food, use the following formula:

Percent protein (from guaranteed analysis) divided by percent dry matter (100 minus percent moisture) x 100

Example: Canned food at 8% protein based on GA and 75% moisture, Dry at 27% protein based on GA, 10% moisture:

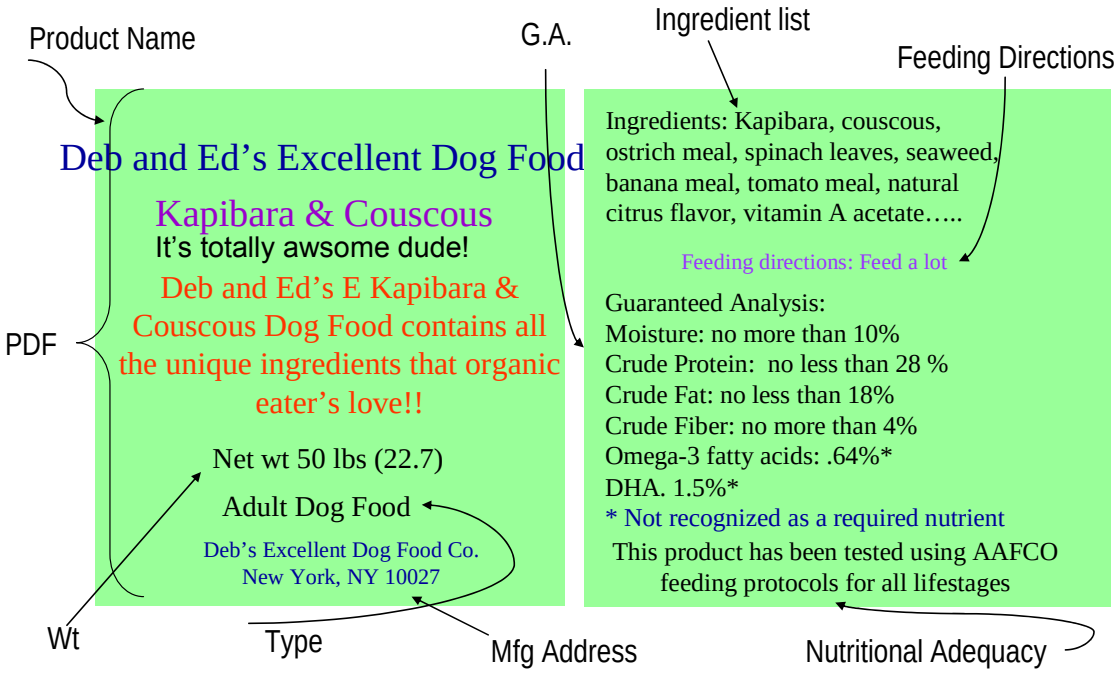
8/25 x100= 32% protein for canned

27/90 x 100 = 30% protein for dry

Calorie Content

The calorie content of the food is not stated in the guaranteed analysis. Often calories are listed as kilocalories per kg of food which is the most accurate way to list calories; sometimes companies will give the number of calories per cup which is how most consumers measure food.

How To Interpret a Dog Food Label



8 yr old spayed female Dalmatian

- Owner is concerned about weight gain after vet suggested dog should go on diet
- Sensitive to many types of food: beef, liver
- History of urate stones
- Weighs 88 lbs (40 kg) should weigh 66 lbs (30 kg)
- What food do you recommend?
  - What quantity do you recommend?

Foods for fat Dalmatians

- Weight management (chicken&rice)
  - Good choice: Reduced fat, increased protein food, glucosamine
  - Amount: 1020 kcal at 337/cup = 3 cups
- Turkey & Barley Senior
  - Good choice: Increased protein, not as reduced in fat, higher glucosamine
  - Amount: 1020 kcal at 417/cup = 2 and 1/3 cups
- Senior
  - Good choice: Increased protein, not as reduced in fat as WM but lower than T&B, glucosamine (not as high as T&B)
  - Amount: 1020 kcal at 439/cup = 2 cups (unhappy dog!)

A Veterinarian- Breeder's View--Use of OFA & PennHIP

Ray Calkins, DVM

Canine hip dysplasia (CHD) was first described in 1937 and is the most common degenerative joint disease (DJD) in dogs. It is present in almost all breeds and has a world wide distribution. CHD is considered to be a disease of complex inheritance, and thus the clinical signs may vary from mild to severe. In the United States, two nonprofit organizations have been formed to diagnose and grade CHD. Through the use of the results from these organizations, responsible breeders can reduce the incidence of this costly and debilitating disease.

The Orthopedic Foundation for Animals (OFA) was founded in 1966. John M. Olin, an industrialist, sportsman and field trailer is generally credited for its foundation. He organized the first meeting of veterinarians and breeders to find ways to limit this disease. This meeting led to the formation of the nonprofit organization.

The OFA evaluates hip genetics (genotypes) by radiographs of the pelvis in the "hip extended view". Three board certified radiologists are randomly picked from a pool of 20 - 25 specialists. Their subjective opinions as to the phenotype (the observable physical characteristic that reflects the genetics) of the hip joint is based on a 9 point evaluation of each hip. The hips are classified as Normal (Excellent, Good or Fair), Borderline (needing re-evaluation) or Dysplastic (Mild, Moderate or Severe). OFA will evaluate young animals but will not certify them as Normal until they are two years of age or older. The OFA strongly recommends sedation or anesthesia for hip radiographic evaluations. Submission of hip studies is optional with OFA. Owners may elect not to submit radiographs of dogs with obvious DJD. Therefore, the OFA data is biased by evaluating primarily dogs that have the possibility of receiving a normal rating.

At the University of Pennsylvania in 1983, Gail Smith started researching a technique for the early diagnosis of CHD. This research led to the establishment of the PennHIP method of predicting the likelihood of a dog developing DJD of the hip or CHD. In 1994 this technique was licensed to an outside company and became commercially available. The University of Pennsylvania regained PennHIP and established nonprofit status for the organization in November 2002.

PennHIP utilizes three radiographic views of the pelvis to scientifically evaluate the hip's phenotype. The hip extended view (the first radiograph and the same view used by OFA) is evaluated subjectively for degenerative changes (DJD). Then a "compression film" is taken utililizing a lateral fulcrum to seat the femoral head as deeply as possible into the socket (acetabulum). The third radiograph called the "distraction radiograph" requires a special adjustable

device that acts as an interior fulcrum to expand the hip joint to the extent allowed by the round ligament and joint capsule. These two radiographs are used to calculate the distraction index (DI) of each hip. The DI is a measurement of joint laxity. The DI is calculated by measuring the radius of the femoral head (r) and the magnitude of separation, or the distance between the acetabular and femoral head centers under distraction (d). DI=d/r [1]. The DI ranges from 0 to >1.

This procedure can be performed as early as 16 weeks of age and the DI is considered to be stable throughout the animal's life. PennHIP utilizes a network of trained veterinarians and anesthesia is required. All studies are required to be submitted to PennHIP for evaluation. A database that contains all studies, tight and lax, gives a truer picture of the hip status for that breed.

Performance Borzois and Greyhounds are two breeds that are recognized to have an extremely low prevalence of CHD and have uniformly tight hips (DI<0.3). The mean DI (hip laxity) from canine breeds known to have a high prevalence of CHD had significantly greater mean DI than Borzois and Greyhounds. Importantly, tight hipped dogs (DI<0.3) within breeds of dogs predisposed to DJD had a similarly low (near 0) risk of developing DJD [1].

PennHIP issues a Hip Evaluation Report on each animal giving a subjective evaluation for DJD of each hip. The objective DI is calculated for each hip and a laxity profile ranking for the dog is shown on a sliding scale for that particular breed.

An ideal test for a genetic disease would be one that is 100% at differentiating genetic normal from abnormal. At this time there is no genetically based test for the polygenetic disease of CHD. Both OFA and PennHIP evaluate the phenotypic appearance of the hips on a radiograph to predict the genotype. These evaluation methods identify true negative individuals (genetically and phenotypically normal) and true positive individuals (genetically and phenotypically abnormal). In addition, there are a few false positive individuals; these are animals with good genes, but who have DJD due to hip trauma. These animals will fail with both OFA and PennHIP. A more disturbing problem is the false negative individual with the hip extended view (this is the sole view of OFA, but only 1 of 3 views obtained for PennHIP evaluation). It has been shown that this view actually "tightens" the joint capsule which can disguise laxity. In addition, manipulation of the hip can reduce the observed laxity on the x-ray. False negatives allow bad genes to remain in the gene pool. Hips that are rated as normal at two years of age with the hip extended view may develop DJD later in life.

It has been shown by PennHIP that a "direct comparison of the official OFA score with DI in a pool of 260 large breed dogs showed that a large proportion of dogs that had officially passed as excellent, good or fair had DI scores in excess of 0.3" [1]. Dogs that have passed OFA as excellent or good may have occult lax hips. Not all lax hips will develop DJD, but laxity is a predictor of susceptibility to CHD. Knowing the DI of your breeding stock may answer the question why your "OFA Good" stud dog develops DJD later in life or

why he occasionally produces dysplastic offspring.

The OFA recommends breeding only dogs that received a 'Normal' rating to bitches who also received a 'Normal' rating. To get better results in reducing the incidence of CHD, the OFA recommends breeding 'Normal' dogs that come from 'Normal' parents and grandparents, and that breeding 'Normal' dogs that have more than 75% 'Normal' siblings will result in more rapid improvement. In addition, the OFA recommends choosing replacement animals that exceed the breed average.

PennHip states that to get maximum genetic change, one must breed ONLY dogs with a DI of less than 0.3. These animals have almost zero chance of developing CHD. This approach dramatically limits breeder choices and genetic diversity. Because of this, PennHIP advocates a more moderate approach—use only animals with hips tighter than the breed's average as breeding stock. In this way the breed moves to tighter hips with less chance of developing CHD over time while maintaining the other desired traits of the breed.

All breeding stock should be evaluated for CHD. Early elimination of high risk individuals reduces the economic and emotional loss caused by the disease. Both OFA & PennHIP agree that hip laxity is the major contributing factor leading to the formation of CHD. PennHIP evaluation at a young age (4 mo - 1 yr) will allow breeders to concentrate their time and energy on a pup that has a better than average hip for their breed. Prior to making the decision to breed an individual dog, a radiograph at two years of age should be taken to detect if DJD is present. Both OFA and PennHIP make this evaluation. The combination of early evaluation for laxity by PennHIP and OFA certification at two years of age will over time improve the hip status of your kennel and breed.

Additional information may be obtained from:

[1] Kapatkin, AS, Fordyce, HH et al. Canine Hip Dysplasia: The Disease and Its Diagnosis. *Compend Contin Educ Vet* 24:526-535, 2002.

[2] Kapatkin, AS, Fordyce, HH et al. Genetic Control of Canine Hip Dysplasia. *Compend Contin Educ Vet* 24:681-687, 2002.

[3] Keller, G: *The use of health databases and selective breeding A guide for dog and cat breeders and owners*, Orthopedic Foundation for Animals, Inc 4th Edition 2003.

[4] OFA website: www.offa.org

[5] PennHIP website: www.pennhip.org

Abnormalities of the canine estrous cycle: A review

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Introduction

The estrous or reproductive cycle of the canine includes four stages: proestrus, estrus, diestrus, and anestrus [1]. To truly recognize what is abnormal, one must have an understanding of what is considered normal for the canine estrous cycle. The bitch is classified as a monestrous animal, meaning that there is only one estrus period per estrous cycle [2]. Other mammals such as cattle, horses, and swine return to estrus every three weeks during the breeding season unless pregnant, and when pregnancy occurs, this period is much longer than the normal diestrus period. In contrast, the canine differs from these animals in several aspects [3]. First, each cycle is at least five months in duration. Second, the diestrus period is not changed significantly by pregnancy and is approximately the same duration. Third, a long period of relative ovarian inactivity occurs between cycles, called anestrus. The anestrus period occurs regardless of pregnancy status.

2. The normal canine estrous cycle

The normal estrous cycle of the canine can be described in several different ways, including behavioral aspects, clinical findings, hormonal values, and cytologic findings of the vaginal epithelium. The four stages of the canine estrous cycle will be reviewed according to these classifications. It is important to remember that the length of each stage of the estrous cycle in the bitch can vary from cycle to cycle. This means it is not dependable to expect that breeding on a given day of the cycle will be repeatable on any ensuing cycle.

2.1 Proestrus

The average duration of proestrus in mature bitches is nine days, with a normal range of 0 to 27 days [4]. Proestrus is usually simply defined as that stage of the estrous cycle where noticeable signs of serosanguinous (thin, bloody) vaginal discharge begin. Varying degrees of bloody vaginal discharge are typically seen. The nature of the discharge is typically bright red and voluminous at the onset of proestrus and then becomes less voluminous towards the end. However, it should be noted there is great variation amongst bitches in regards to the amount and nature of their discharge. During proestrus, females are attractive to male dogs, but generally refuse matings. Pheromones, which are present in the female's vaginal secretions, anal sac expressions, and urine are responsible for this attractiveness [5-8]. Sexual reflexes such as flagging of the tail (elevation of the tail away from the vulva and swaying of the hips from

side to side) in response to touching the perineal region (area between and including the anus and vulva) begin in proestrus [9]. The vulva slowly enlarges throughout proestrus due to edematous (turgid) swelling. As proestrus progresses, this swelling gradually subsides and the vulva is less turgid.

Hormonally, the proestrual bitch is under the influence of estrogen and this is the dominant hormone during this stage of the cycle. Estrogen is responsible for most of the clinical signs seen in bitches during proestrus, because this hormone stimulates growth and activity of the glandular epithelium of the uterus and promotes swelling and increased vascularity of the lining of the uterus (mucosa) [3]. The serosanguinous vaginal discharge is a direct result of these effects because the junctions between the cells lining the capillaries leak and permit passage of red blood cells into the uterine lumen which is eventually discharged vaginally after passage through the cervix. Serum progesterone concentrations during proestrus are at basal levels (<0.5 ng/mL) and then start a gradual rise at the end of proestrus. Preovulatory follicular luteinization (transformation of the estrogen secreting follicle to a progesterone secreting structure), unique to the canine, is responsible for this increase in progesterone concentration [10,11].

The effects of estrogen dominance during proestrus are also reflected when vaginal cytology is evaluated. Exfoliated (sloughed) vaginal epithelial cell types vary during proestrus and are usually accompanied by numerous red blood cells. As proestrus progresses, the percentage of superficial and large intermediate cells increases, while numbers of parabasal and small intermediate cells decline.

2.2 Estrus

Estrus in the canine is characterized by the bitches willingness to allow mounting and intromission. The estrus phase begins with this acceptance of the male and ends when the bitch no longer permits a mating. The average duration of estrus in the bitch has been reported to be nine days, with a range of 4 to 24 days [4].

Clinically the bitch attracts males during this phase and also exhibits flagging of the tail, similar to that in proestrus. However, in estrus the vulva becomes less turgid and more soft and flaccid. The character of the vaginal discharge is also different in estrus in most bitches and is classically straw-colored due to the diminishing presence of red blood cells. Some bitches, however, may continue to have a serosanguinous vaginal discharge through the estrus period.

Hormonally, the bitch appears to be receptive to the male in estrus due to declining estrogen levels and increasing progesterone levels [9,12,13]. Serum progesterone concentrations gradually and steadily rise during estrus. At the start of estrus, progesterone concentrations are typically near 1.0 ng/mL and reach levels near 2.0 ng/mL at the preovulatory LH (Luteinizing Hormone) surge. At the time of ovulation two days later, the serum progesterone concentration is typically in the range of 4.0 to 10 ng/mL [14]. Progesterone concentrations

continue to rise after ovulation and reach peak levels in diestrus.

Cytologically, estrus can be defined by the presence of greater than 90 percent of the vaginal epithelial cells being superficial cells [15]. Fewer red blood cells are also present during estrus and white blood cells are rare to absent.

2.3 Diestrus

Diestrus is the phase of the cycle that follows estrus and is characterized by progesterone dominance. The duration averages 56 to 58 days in pregnancy and 60 to 100 days in the nonpregnant bitch [14]. Diestrus is generally considered to occur clinically when the estrus bitch first refuses a mating. Bitches are also less likely to be attractive to males at this time.

Progesterone secretion is maximal approximately 2 to 3 weeks after the beginning of diestrus and reach peaks of 15 to 90 ng/mL at this time [16]. After this peak, progesterone gradually declines over the remainder of diestrus.

It has been suggested that the onset of diestrus be defined by vaginal cytology rather than mating behavior because events such as whelping can be more accurately timed [17]. When defined by vaginal cytology, the onset of diestrus occurs when there is a sharp decrease in the percentage of superficial cells and an increase in the percentage of small intermediate and parabasal cells. Neutrophils, metestrual cells and foam cells are commonly seen as well during diestrus.

2.4 Anestrus

Anestrus is the quiescent phase of the canine reproductive cycle when defined by behavioral or clinical signs [1]. Bitches in anestrus are not attractive to males and are not receptive to mating. The vulva is normally small and there is no discharge present. In the pregnant bitch, anestrus is the stage of the cycle when uterine involution occurs, beginning with whelping and ending with proestrus. In the nonpregnant bitch, the onset of anestrus is not readily discernable clinically from the end of diestrus.

Anestrus is often defined endocrinologically as the phase following diestrus when progesterone levels decline to less than 1.0 to 2.0 ng/mL.

Predominant cell types present in vaginal cytology specimens in anestrus include parabasal and small intermediate cells.

Similar to other phases of the estrous cycle, there is normal variance in the duration of anestrus. This variation depends on breed, health, age, time of year, environment, and multiple other factors [14]. The approximate duration of anestrus in the bitch is 4 to 4.5 months. Following pregnancy the length of anestrus may be extended by 1 to 2 months.

3. Puberty

In the bitch, puberty is recognized when the first signs of proestrus occur. Onset of puberty in the bitch is breed-dependent, beginning between 6 and 10 months of age for bitches of many smaller breeds but may not begin for up to 24 months in bitches of some larger breeds [18,19]

4. Failure to exhibit estrus at the expected time

4.1 Primary anestrus

Primary anestrus is defined by the lack of estrous cycling in a bitch by 24 months of age [20]. Some large-breed dogs may not experience their first estrus until approximately this time so investigation into failing to cycle before 24 months may not be necessary. Causes of primary anestrus in the bitch include previous ovariohysterectomy (spay, OHE), silent heat, abnormalities of sexual differentiation (chromosomal or genetic defects), drug-induced anestrus, congenital hypothyroidism, underlying systemic disease, and ovarian abnormalities [1].

4.1.1 Previous ovariohysterectomy

Although this differential diagnosis may seem simplistic and obvious, it is a real possibility due to the fact that many puppies may be neutered at an early age and owners may not be aware of this if it occurs prior to their ownership. The presence of a midline abdominal scar is suggestive but not definite confirmation of previous ovariohysterectomy (OHE), as surgeries for other reasons are achieved via a similar incision. Serum LH is elevated in ovariectomized bitches due to the lack of negative feedback from the nonexistent ovary, and can be used as a diagnostic aid to determine if a female has had a previous OHE [21,22] Elevations in LH are suggestive for previous OHE, but ovarian dysfunction or the preovulatory LH surge can also result in a similar LH elevation. Repeated elevations in LH (over a 2 to 3 week period) make the diagnosis of prior OHE more likely. Definitive diagnosis for previous OHE is via exploratory surgery.

4.1.2 Silent heat

Silent heat is defined as ovarian activity with no associated vulvar swelling, serosanguinous vaginal discharge, or attractiveness of male dogs [20]. While ovarian activity is occurring normally, no outward signs of “heat” are observed by owners or by other dogs, including intact males. Serum progesterone concentrations can be measured on a monthly basis to determine if functional ovaries are present. Levels greater than 2.0 ng/mL indicate the presence of functional luteal tissue [20]. Vaginal cytology can also be assessed on a regular basis to determine if percentages of superficial epithelial cells are increasing. Increasing percentages suggest influence of estrogen and functional ovarian tissue. Silent heats are not uncommon [21] and can make determining if a young bitch is truly anestrus or not difficult.

4.1.3 Abnormalities of sexual differentiation

Females can have normal appearing external genitalia but have abnormal gonads due to aberrant chromosome complements. One such example is male pseudohermaphroditism, where an animal has male gonads but normal external female genitalia. Diagnosis includes assessment of the karyotype and histopathology of the excised gonads [1].

4.1.4 Drug-induced anestrus

Drugs such as androgens and progestins prevent estrous cycles in bitches. Additionally, exogenous (administered by humans or ingested vs. being produced by the animal itself) glucocorticoids have also been shown to affect serum LH and normal cycling [22]. Diagnosis is via thorough history taking when bitches present for anestrus, including any medications the owners or family members may take for their own health problems that may inadvertently affect the bitch through contact (i.e. hormone patches and lotions).

4.1.5 Hypothyroidism

While clinical reproductive signs have been *reported* in approximately ten percent of hypothyroid bitches and primary anestrus has been a *reported* sign resulting from hypothyroidism there is now good evidence that there is little or no effect of hypothyroidism on reproductive function [1,23-25]. Congenital hypothyroidism may result in primary anestrus but is reversible with replacement of L-thyroxine.

4.1.6 Systemic disease

Any systemic disease may have a negative impact on reproductive function. Hyperadrenocorticism (elevated cortisol in the bloodstream) [26], renal (kidney) failure, and neoplasia (cancer) are some examples of systemic diseases that may impact normal cycling. Diagnosis is via thorough physical exam and screening labwork such as a complete blood count, serum chemistry profile, and urinalysis.

4.1.7 Ovarian abnormalities

Ovarian abnormalities that may cause primary anestrus include a progesterone-secreting ovarian cyst, ovarian aplasia (failure of the ovary to develop normally), and immune-mediated oophoritis (inflammation of the ovary) [1]. Definitive diagnosis of these conditions includes histopathology of ovarian tissue.

4.2 Secondary anestrus

Secondary anestrus, or prolongation of the interestrous interval, is failure to cycle by 10 to 18 months of the previous cycle [27,28]. Knowledge of normal breed characteristics is necessary, as some dogs that may have apparent prolonged interestrus intervals may actually be normal for that breed (i.e. Basenji, Tibetan Mastiff) [29].

Secondary anestrus can be exhibited with concurrent hypothyroidism, hyperadrenocorticism, or potentially any other nonendocrine disease. Silent heats, although more common at the pubertal estrus, should also be included in

the differential diagnosis.

5. Persistent estrus

Persistent estrus is defined as combined proestrus and estrus of greater than six weeks [30] or willingness to breed for longer than 21 to 28 consecutive days in any one ovarian cycle [14]. Persistent estrus can also be defined if superficial vaginal epithelial cells predominate on vaginal cytology for more than 21 to 28 consecutive days. Persistent estrus may be a direct result of endogenous (produced by the animal itself) estrogen production or exogenous estrogen administration [31]. Sources of external estrogen may include contact with human estrogen patches or lotions, ingestion of human estrogen supplements, ingestion of foods with high estrogen content (moldy foods), or during treatment for urinary incontinence or vaginitis with estrogens. Serum estrogen levels are frequently not elevated in bitches with persistent estrus [32], and serum progesterone values typically stay in the preovulatory range (<2.0 ng/mL) [31,32].

Bone marrow suppression is a concern in bitches with persistent estrus because of estrogen toxicity. The secondary signs of estrogen toxicity most commonly include a nonregenerative anemia (a low red blood cell count that does not correct itself) and thrombocytopenia (low platelet count).

Causes of true persistent estrus include functional ovarian follicular cysts, granulosa cell tumors, or exogenous estrogen administration. Other reported causes include hepatic (liver) portosystemic shunts [29] and idiopathic lymphocytic oophoritis (immune-mediated ovarian inflammation) [33]. One should also consider the ranges of normal for duration of proestrus and estrus in the bitch, as proestrus can last nearly four weeks and estrus as long as three weeks in some bitches.

Ultrasonography is a valuable diagnostic tool in determining the cause of persistent estrus in the bitch. Intervention has been recommended if 21 days of estrus have been documented to prevent bone marrow suppression and pyometra [32]. Methods of intervention include hCG (human chorionic gonadotropin) or GnRH (gonadotropin releasing hormone) administration or OHE. Functional ovarian follicular cysts may respond to hCG but granulosa cell tumors will not. OHE is recommended if hCG administration fails, and subsequent histopathology of ovarian sections can then provide a definitive diagnosis.

6. Irregular estrus

6.1 Shortened interestrus interval

Endometrial involution and repair is a necessary phase after an estrous cycle and requires from 130 to 150 days in the bitch [29]. Subfertility is generally expected when interestrous intervals are less than four months in duration [28,29]. Length of interestrous interval is influenced by breed, with shorter intervals being a common finding in German Shepherd dogs, Rottweilers, Basset hounds, Cocker Spaniels, and Labrador Retrievers [29,34,35]. In addition to incomplete uterine involution, shortened interestrous intervals may be seen in

bitches with uterine disease [29,36,37]. One such common uterine disease is cystic endometrial hyperplasia (CEH). Treatment of bitches with short interestrous intervals due to uterine disease is induction of anestrus with a synthetic androgen such as mibolerone [1].

6.2 Split heat

Split heat has been defined as appearance of physical and behavioral changes characteristic of proestrus with no progression through ovulation and estrus. A short anestrus period follows which lasts days to weeks, and then this is followed by a normal, fertile estrous cycle [1]. Similar to silent heats, they are more commonly seen in young pubertal bitches but can be exhibited by bitches of any age. Split heats may be caused by insufficient gonadotropin release or break-through bleeding at onset of folliculogenesis (follicle development) [38].

Split heats can be confusing because the anestrus period between the two "heats" can be 2 to 10 weeks in duration and can appear similar to a shortened interestrous interval. Serum progesterone monitoring helps to differentiate the two as ovulation does not take place in the first "heat" of a split heat. Progesterone levels during the first "heat" of a split heat likely will not exceed 4 to 6 ng/mL because ovulation does not occur. No association exists between split heats and later infertility or between split heats and ovarian and uterine disorders [14].

6.3 Anovulation

Anovulation is simply defined as failure of ovulation, in which serum progesterone concentrations fail to exceed 4 to 8 ng/mL during cytologic estrus [32]. Anovulation is related to a split heat because it can be the first stage of a split heat. Anovulation has been reported to be an uncommon clinical finding, with incidences of approximately one percent [39,40]

Suggested causes of anovulation include failure of the ovary to deliver a sufficient estrogen signal to cause an LH surge, failure of the hypothalamus to secrete sufficient GnRH or the pituitary to secrete sufficient LH, or failure of the ovary to respond to a normal LH surge [32].

Although reported therapies for anovulation include GnRH or hCG [41], treatment may not be appropriate because of the possibility that this is a heritable condition.

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