FELINE AND CANINE NEONATAL AND PEDIATRIC CARE

A PRACTICAL GUIDE FOR VETERINARIANS

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EDITIONS

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A PRACTICAL GUIDE FOR VETERINARIANS

INTRODUCTION

Cécile Coutens

Global President at Royal Canin

Life is a miracle. Protecting its earliest moments and meeting all the needs of the critical stages of its development is a labor of love, care, and dedicated work. Providing the best possible care right from the womb can make such a difference to the most vulnerable hours of life, as well as laying the best possible foundation for health and well-being.

It takes more than a decade for a baby to become an adult, whereas a cat or a dog will reach adulthood in just 8 to 18 months. This is the time when all the critical microbiome, immunity, cognitive functions develop, and care habits are formed. Unfortunately, puppies and kittens are too often considered far too early as adults they are not yet.

The publication of this first-ever Royal Canin Neonatal and Pediatric care guide for cats and dogs is therefore a very meaningful step in the advancement of pet health care. It has brought together and articulated the best of existing scientific and observational knowledge to meet the needs of all pet professionals involved in the early life of cats and dogs, especially veterinarians and nurses. We are only at the beginning of demonstrating what great care at the start of life can do, and we will continue to research, learn and advance pediatric care.

I want to thank our authors for their incredible expertise, experience, and commitment in developing this guide. I also want to thank the many practitioners whose daily care of puppies and kittens makes all the difference.

All puppies and kittens deserve a great start and the best support through their growth. It can be done. And it matters.

Let's do it together!

Cécile Coutens

Denise Elliott

BVSc (Hons), PhD, Dip. ACVIM, Dip. ACVN
R&D VP at Royal Canin

Dr. Elliott received her degree in Veterinary Medicine from the University of Melbourne in 1991. After completing an internship in Small Animal Medicine and Surgery at the University of Pennsylvania, she completed a residency in Small Animal Internal Medicine and Clinical Nutrition at UCD. Denise Elliott became a ACVIM diplomate in 1996 and an ACVN diplomate in 2001, the same year in which she received her PhD in Nutrition from UCD for her work on multifrequency bioelectrical impedance analysis in healthy cats and dogs. She is currently Vice-President for Research and Development at Royal Canin.

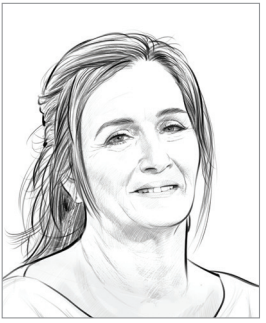
We believe that pets make our lives better, so it is our duty, indeed our responsibility, to make the world a better place for them. How can we achieve this?

First and foremost, we always put the cat's and dog's needs first. Contributing to the health and well-being of cats and dogs is at the very heart of Royal Canin's philosophy and culture. Their real needs guide our actions, steer our science, and inspire the nutritional philosophy behind all of our foods. Dogs and cats are always our priority.

Secondly, we challenge ourselves to continually push the boundaries of our knowledge by working in partnership with professionals and scientific communities, using science and observation to develop and gain an in-depth understanding of the precise needs of cats and dogs. Most importantly, we want to share this knowledge with others, so that they can better care for the dogs and cats in their care.

So it is not surprising that the sole aim of this practical guide is to share knowledge to make the world a better place for pets. It has been written thanks to the collective intelligence of our team of in-house and external experts, a unique group of individuals united and driven by a passion to ensure that every puppy and kitten gets the best possible start in life and has the chance to live up to their potential for a long, happy, and healthy life. In this guide, you will find concise, easy-to-understand articles to help you answer the many questions you may have, from preparing for parturition to weaning and successful adulthood. Thank you for everything you do every day to help us achieve our goal: to make the world a better place for pets.

Denise Elliott



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Dr. Tal graduated with honors from the Ontario Veterinary College in 1992 and worked in a Canadian private practice for several years before relocating to Israel, where she established a successful private small animal practice near Tel Aviv, which she ran for 22 years. She became a diplomate of the American College of Theriogenologists in 2011 and went on to obtain her diploma from the European College of Veterinary Reproduction in 2014. She is currently head of the Small Animal Theriogenology department at the Koret school of Veterinary Medicine and received her PhD from the Hebrew University of Jerusalem in 2023. Her research interests include various aspects of canine pregnancy and neonatology, feline contraception and canine gene therapy, as well as clinical research involving wildlife.

Welcome to the world of canine and feline reproduction, a fascinating journey that encompasses the miraculous process of parturition and the delicate care given to newborns during the first stages of their lives until they reach adulthood.

This practical guide is a comprehensive resource designed to equip practicing veterinarians who seek to better understand the critical stages and responsibilities involved in the reproductive journey of dogs and cats.

In the first part of this guide, we cover the essential aspects of preparing for motherhood, including proper nutrition during gestation, vaccination to preserve health, and deworming to prevent potential complications. In addition, we explore the special and pathologic conditions that may occur throughout pregnancy and how to manage them.

As the due date approaches, this guide then provides expert advice on the equipment and preparations essential to create an environment conducive to a stress-free birthing experience. It also covers routine and emergency antenatal obstetric examinations to ensure the well-

being of both dam and offspring. Moreover, recommended equipment for use during parturition in veterinary clinics to effectively manage any unforeseen complications effectively is described.

The section on parturition focuses on managing the birthing process itself, as well as the potential challenges of dystocia. Discussion focuses on how to determine the expected date of parturition and recognize warning criteria for potential complications. Obstetric management decision trees are provided to aid rapid and appropriate decision-making, while medical management options are explored to ensure a smooth and successful delivery. In cases where a cesarean section is necessary, crucial aspects of the cesarean section procedure are described. The circumstances that may necessitate an elective cesarean section are discussed, as well as the optimal timing for this procedure.

Detailed discussions on anesthesia, analgesia, and the surgical description of a cesarean section are included to guide veterinarians through this critical procedure.

The neonatal phase requires delicate care and early intervention. From neonatal resuscitation to tube feeding guidelines, this practical guide covers all the crucial aspects of early care, empowering veterinary staff to support newborn puppies and kittens with confidence. The postpartum care of the dam is also covered, including colostrum production, nutrition, and maternal behavior. In addition, we explore postpartum pathologies, ensuring the health and well-being of both mother and offspring.

As our young companions make the transition from newborn to adult, this guide continues to provide veterinary staff with knowledge on preventive medicine, behavior management, and pathologies. The importance of early socialization, proper nutrition, and obesity prevention in fostering healthy, fulfilling lives for our pets is emphasized.

Throughout this guide, we aim to provide comprehensive knowledge, practical guidelines, and evidence-based insights to enable veterinary staff to support breeders and pet owners. Our collective aim is to ensure the health, happiness, and longevity of both dams and their precious offspring at all stages of life. This practical guide can be used during the consultation for a quick check-up and between consultations for a deep dive.

Smadar Tal

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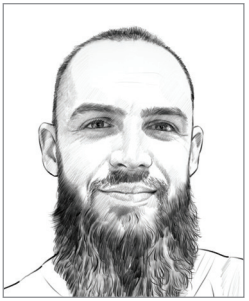

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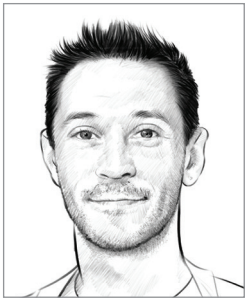

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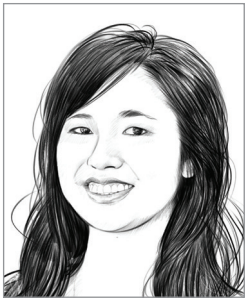

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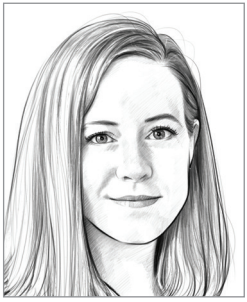

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PREPARATION TO PARTURITION

NUTRITION DURING GESTATION

The periods of gestation and lactation are the most energy and nutrient-demanding times in an animal's adult life. Feeding an appropriate diet that meets nutritional requirements is vitally important to ensure the health of both the dam and her litter.

Diet suitability for reproduction

Commercial diets should have a nutrition adequacy statement **(Box 1)** on the label indicating that they have been formulated appropriately, or have undergone a feeding trial. They should also meet the nutrient requirements for reproduction (gestation/lactation) or for all life stages. Home-prepared diets should be formulated by a certified veterinary nutritionist to ensure all essential nutrients are available in safe concentrations. Because of the risk of bacterial and parasitic contamination, we recommend cooking raw meat-based diets before feeding.

Supplementing nutrients in addition to a properly formulated diet is not advised. For instance, supplementing with additional calcium can result in reduced mobilization of calcium from body stores by the parathyroid hormone, and put the mother at risk of eclampsia (low blood calcium) during lactation.

Dietary supplementation with certain nutrients may be of interest during this critical period. For instance, folic acid for the development of the neural tube of the embryo or DHA (docosahexaenoic acid) for the brain structures (and retina) of the fetus.

Energy requirements

The amount of food a dam needs depends on the species and stage of gestation. The energy requirements of canine dams does not increase significantly until ~6 weeks (42 days) of pregnancy, when the fetuses start growing exponentially. Therefore, canine dams should receive 10% additional calories every week after 6 weeks of gestation. Multiple small meals may be needed to help with food intake during the final weeks of pregnancy, when the fetuses occupy a large part of the abdominal space.

Nor do feline dams' energy requirements increase significantly until week six of gestation. However, unlike bitches, queens tend to lose body weight during lactation and so must build a fat reserve during gestation. Feline dams should therefore be fed an extra 10% of calories every week from the start of gestation.

Although additional calories are needed during gestation, excessive weight gain should be avoided. In humans, being overweight or having excess gestational weight gain has been shown to increase the risk of preterm births, low birth weight and pre-eclampsia. In addition, the offspring are at greater risk of becoming overweight during childhood. Therefore, the dam's body weight and body condition score (BCS) should be carefully monitored throughout gestation to ensure adequate, but not excessive, weight gain. For dogs, the aim is to achieve an increase of 15-25% of the dam's premating body weight at the end of her pregnancy. For cats, the target is an increase of 40-50% of the queen's premating body weight **(Figure 1).**

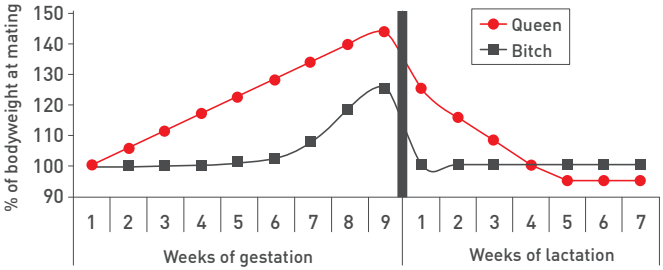


Figure 1. Changes in bodyweight during gestation and lactation in the bitch and queen.

From Fontaine E. Food intake and nutrition during pregnancy, lactation and weaning in the dam and offspring. *Reprod Domest Anim* 2012.

Box 1. Nutrition adequacy statements.

NUTRITION ADEQUACY STATEMENTS ON PET FOOD LABELS

Most pet food manufacturers do not produce diets specifically for gestation and lactation. However, they should still have the adequacy statement confirming suitability for reproduction (gestation/lactation) or all life stages.

Association of American Feed Control Officials (AAFCO)

- "*(Diet name)* is formulated to meet the nutritional levels established by AAFCO Dog/Cat Nutrient Profiles for gestation and lactation/all life stages"
- "Animal feeding tests using AAFCO procedures substantiate that *(diet name)* provides complete and balanced nutrition for gestation and lactation/all life stages"

European Pet Food Industry Federation (FEDIAF)

- Example: "Complete pet food for puppies and gestating/lactating dogs"

VACCINATING THE BITCH AND QUEEN

Due to the hormonal changes during gestation, the immune response of pregnant females is altered, making them more susceptible to infection. In addition, some of the female's circulating immune compounds, such as immunoglobulins, pass to the fetal compartment via the placenta or into the milk via the mammary gland. The female is therefore sensitive to infectious diseases and may develop more serious clinical signs than a non-pregnant adult.

Objectives of vaccination

Vaccination is one of the key elements of protection against infectious diseases. The objective of vaccination is disease prevention for the individual and the population in general. Thus, all animals housed in a facility (including non-breeding animals) should be routinely vaccinated. A complete vaccination program is essential not only for the health of the female, but also for that of her litter.

A correctly vaccinated female will not expose puppies or kittens to pathogens **(Figure 1).** In addition, she will produce colostrum of high immune quality, providing the newborn with specific antibodies at a high concentration. If those antibodies are absorbed in an adequate volume and at an appropriate time, puppies and kittens will be protected against targeted diseases for the following weeks or even months.

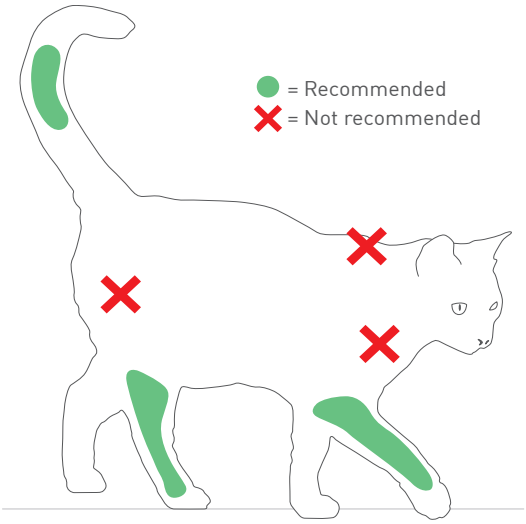


Figure 1. Recommended vaccination sites are shown in green; sites which are often used, but which should be avoided, are shown in red. The vaccine injection site must be recorded in the patient's records.

Choice of vaccines

The choice of vaccines for a breeding kennel or cattery depends on the sanitary situation of the country in which it is situated, as well as that of the facility itself. For instance, vaccines against canine or feline parvovirus would be recommended all over the world (so-called core vaccines), those against rabies would be recommended in countries with circulating rabies, whereas those against canine herpesvirus would only be recommended in kennels with circulating herpesvirus (so-called non-core vaccines). The availability of different vaccines also varies from country to country. The core and non-core vaccines to be used in breeding kennels and catteries are presented below **(Table 1).**

Table 1. Most commonly used vaccines in breeding bitches and queens.

Vaccines	Bitches	Queens
Core	• Canine parvovirus type 2 (CPV2) • Canine adenovirus type 1 (CAD1) • Canine distemper virus (CDV)	• Feline panleukopenia virus (FPV) • Feline calicivirus (FCV) • Feline herpesvirus (FHV)
Non-core	• Canine herpesvirus type 1 (CHV1) • Canine parainfluenza virus (CPIV) • Canine coronavirus (CCoV) • *Bordetella bronchiseptica* • *Leptospira* spp. • Rabies	• FeLV • Rabies • *Chlamydia felis*

Vaccine boosters

Although protection is generally maintained for several years after core canine and feline vaccination, this should not be assumed for breeding bitches and queens. Due to a higher exposure to the infectious agents, the altered immune status of the pregnant female, and antibody passage into the colostrum, all breeding females should be revaccinated at least annually, or even biannually if there is an increased risk of exposure to certain infectious agents *(e.g.,* FHV).

Vaccination during gestation

Generally, vaccinations of pregnant females should be avoided because of the risk of transferring the virus to the fetus causing fetal damage (modified live virus or MLV vaccines), or abortion due to the strong immune response to the vaccine (both MLV and inactivated or killed vaccines). Vaccination against canine herpesvirus is one of the exceptions (see after). Furthermore, some killed vaccines can be administered to previously unvaccinated pregnant females before and during the onset of disease in the facility *(e.g.,* CDV, FPV). In this case, the vaccination should be scheduled preferably during the second part of gestation.

- Meetings at dog and cat shows, dog training centers, etc. should be avoided during gestation.
- Booster vaccination is recommended – at least once a year – in breeding bitches and queens ideally about 1 month before mating.
- Whatever the country and the health status of the breeding facilities, females should be vaccinated against the CORE valences.
- Vaccination during gestation should be avoided (except against CHV).

Vaccination against canine herpesvirus

Canine herpesvirus infection may lead to abortion and neonatal mortality in infected bitches. Bitches with a diagnosis of herpesvirus infection should be routinely vaccinated at each gestation. The vaccination protocol consists of 2 injections: the first administered at about 7-10 days post-mating and the second at about 10-14 days before the estimated date of parturition. Vaccination aims at increasing the quantity of the herpesvirus-specific antibodies in the colostrum, thereby improving the immune protection of newborn puppies.

Biosecurity in the breeding facility

To reduce the risk of infection in females, general biosecurity rules should also be applied in breeding facilities. Pregnant females should not participate in any events with a high dog or cat density, and/or with animals of unknown origin (dog or cat shows, dog training centers, and dog or cat boarding). Partial or complete isolation from the other animals in the kennel or cattery is also recommended, especially in facilities with a high density and large number of animals.

DEWORMING THE BITCH AND QUEEN

Parasite control is essential in the pregnant bitch and queen. Indeed, up to 25% of puppies and kittens suffer from digestive disorders during the weaning period, with parasitic infestation being the main cause of weaning diarrhea *(Giardia* spp., *Toxocara* spp., coccidia). Some other parasites may cause neurological *(Neospora caninum)* or respiratory disorders *(Toxocara* spp.) in growing animals. Finally, some can lead to abortion, early mortality or long-term health issues *(Neospora caninum, Leishmania infantum).*

Routes of parasite transmission to the fetus or newborn

Quite often, the dam is the primary source of parasites for the newborn, and is an asymptomatic carrier shedding the parasites in the environment or via feco-oral transmission. In some cases, transmission to the young takes place during gestation, as certain parasites may cross the placental barrier **(Table 1).** Such is the case with *Toxocara canis*, a ubiquitous enteropathogen of the dog, unlike *Toxocara cati* in the cat, in which no transplacental transfer is observed. For both species of *Toxocara*, transmission to the newborns is also possible via the maternal milk. The routes of parasite transmission to the fetus or newborn are presented below.

Table 1. Routes of parasite transmission.

	Semen	Transplacental	Milk	Feces	Urine
Toxocara canis	-	+	+	+	-
Giardia spp.	-	-	-	+	-
Cystoisospora spp.	-	-	-	+	-
Toxoplasma gondii	+	+	+	+	-
Neospora caninum	?	+	?	+	?
Leishmania infantum	+	+	-	-	-
Encephalitozoon cuniculi	?	+	?	+	+
Ancylostoma spp.	?	+	+	+	-
Uncinaria stenocephala	?	+	+	+	-

Parasite control

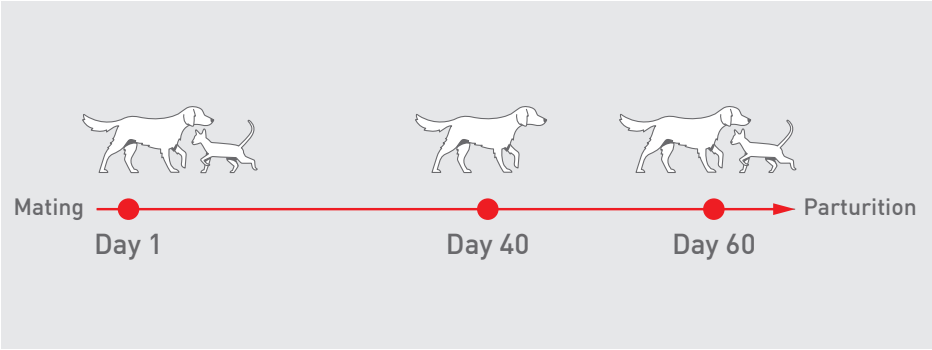
The high prevalence of parasites and the potentially serious consequences for the offspring's health underline the importance of parasite control in breeding females **(Figure 1),** in particular against *Toxocara* spp. Bitches and queens need to follow a routine antiparasitic program, with anti-endoparasitic drugs administered every 3 months, as recommended by European Scientific Counsel Companion Animal Parasites (ESCCAP).

Care must be taken in the choice of drugs administered during pregnancy, as only a few formulations are registered and authorized for use in the pregnant female. Some drugs can cause fetal toxicity or congenital abnormalities.

Deworming is also highly recommended at mating, especially if the male is from outside the facility. Transplacental transmission of *Toxocara canis* to the fetus can occur from day 40 of gestation, it is therefore recommended to deworm the bitch at least once around this date. Finally, in both cats and dogs, as *Toxocara* spp. is transmitted via the maternal milk, the administration of antiparasitic agents is recommended during colostrogenesis, around day 60 of gestation.

According to ESCCAP, the following active substances are considered safe during pregnancy in bitches and queens: fenbendazole, ivermectin, pyrantel, praziquantel, selamectin and milbemycin oxime. Note that the use of ivermectin is not recommended in dogs carrying the MDR–1 gene (Australian Shepherds, Border Collies, Old English Sheepdogs, Shelties, German Shepherds, Bobtails, American White Shepherds).

Figure 1. Timeline of endoparasite control in the pregnant bitch and queen.



LUTEAL INSUFFICIENCY AND SUPPLEMENTATION WITH PROGESTERONE

Hypoluteoidism is characterized by insufficient progesterone secretion by the *corpora lutea* (CL) during pregnancy and is most commonly observed between days 20 to 35 of pregnancy in bitches.

Physiopathology

Throughout the entire canine pregnancy, progesterone originates only from the CL. In both cycling and pregnant bitches, the regulation of luteal function differs between the first and the second halves of the luteal phase. In the first half of pregnancy, the CL function independently of pituitary support. During the second half, luteotropic factors produced by the pituitary gland, such as prolactin and possibly LH, are necessary to maintain luteal function.

Precaution
When the interestrous interval is shortened by estrus induction with deslorelin, serum progesterone concentrations are lower than normal from days 35 to 56 of diestrus, and abortion is possible.

The bitch ovulates at progesterone concentrations of about 15.90-31.80 nmol/L (5-10 ng/mL). The concentrations increase to > 79.50 nmol/L (25 ng/mL) within 3-4 weeks and then subsequently decrease after a plateau of 7-14 days. The uterus is not involved in the regulation of the CL during the luteal phase of the estrous cycle or during pregnancy, except for secreting PGF2α 24-48 hours before parturition which induces progesterone to drop to < 6.36 nmol/L (2 ng/ mL). Progesterone concentrations of around 6.36 nmol/L (2 ng/mL) are thought to be necessary for maintaining pregnancy. Failure for several days to maintain progesterone concentration above this critical level is likely to result in abortion, as progesterone is involved in endometrial development, promotes placental integrity, and inhibits uterine motility.

Diagnosis

Hypoluteoidism can be challenging to diagnose, because a decrease in plasma progesterone concentration is a normal physiological response to fetal distress and it accompanies premature delivery or abortion, whatever the cause. In bitches suspected to have luteal insufficiency, weekly progesterone determinations using quantitative tests should be performed 7 days after mating or at least on the day of early pregnancy diagnosis. The frequency must be increased in the case of progesterone concentrations below 31.80 nmol/L (10 ng/mL). Progesterone administration is indicated in the case of viable fetuses and progesterone concentrations < 15.90 nmol/L (5 ng/mL) before day 58/60 of pregnancy or after the detection of a rapid progesterone decline of about 15.90-31.80 nmol/L (10-15 ng/mL) between days 20 and 35 with viable fetuses at the ultrasonographic examination.

Treatment

A variety of progestins, natural or synthetic, have been used to treat apparent luteal insufficiency in bitches. Progesterone can be administered either parenterally or orally. Treatment regimens described for the dog include micronized progesterone 10 mg/kg q8h PO, ally-trenbolone 0.088 mg/kg q24h orally, medroxyprogesterone acetate (MPA) 0.1 mg/kg, orally once daily, progesterone in oil, 1-2 mg/kg, IM, every other day and repositol progesterone 2 mg/kg every 3 days IM. Treatment should not exceed 58-61 days post-ovulation, *i.e.*, around 2 to 3 days before expected parturition, to avoid a prolonged pregnancy with an increased risk of dystocia and stillbirth.

Side effects

Synthetic progestins have a greater risk potential for side effects (masculinization of female puppies and cryptorchidism in male puppies), especially when administered between days 20 and 35 of pregnancy. Facial deformities were reported in one of four puppies in a litter from a bitch treated with MPA for hypoluteoidism. In most cases, the potential benefits of progesterone treatment for hypoluteoidism during the second half of pregnancy outweigh the maternal and fetal risks.

PREGNANCY TOXEMIA IN THE BITCH

Pregnancy toxemia is a metabolic disorder characterized by hypoglycemia and ketonemia, resulting from the bitch's inability to maintain an adequate energy balance associated with increased mobilization of body fat to meet energy requirements. Pregnancy toxemia is an uncommon condition in the bitch, but represents a risk to the dam and her litter.

Physiopathology

Pregnancy and lactation are physiological periods during which bitches undergo several metabolic changes. They result from hormonal changes and an increased energy demand due to the development of uterus, fetuses, placenta and mammary glands. Hypoglycemia during pregnancy is very rare, as dogs can metabolize protein as an energy source. Protein metabolites can be used in the gluconeogensis pathway, which produces glucose during periods of low-carbohydrate consumption or fasting. In the event of prolonged starvation and subsequent hypoglycemia, suppression of insulin secretion will promote mobilization of fat reserves and ketone-producing fatty acid metabolism. This pathology has been described in small breeds as well as in the Labrador, Great Dane and other breeds with large litters. It is considered a rare cause of dystocia.

Sometimes, hypoglycemia aggravates the signs of hypocalcemia, so it is important to monitor both conditions.

Clinical signs

- Anorexia
- Depression
- Weakness
- Inability to stand
- Seizures and coma
- Acetone breath
- Fetal death and toxemia

Diagnosis

- Ketonuria with absence of glycosuria (in diabetes mellitus, both would be elevated), associated with hypoglycemia.
- Blood ß-HB assay methods (the reference values used to assess the serum ketone concentration are classified into three categories: low values [0.5-0.9 mmol/L (15.72-28.30 ng/dL)], medium values [1.9-2.9 mmol/L (59.74-91.19 ng/dL)] and high values [3.4-5.4 mmol/L (106.91-169.80 ng/dL)].
- Elevated liver enzymes due to hepatic lipidosis.

Treatment

Hypoglycemia and ketonemia disappear as soon as the pregnancy ends. During pregnancy the recommended treatment for a hypoglycemic crisis is immediate correction of hypoglycemia by intravenous administration of glucose at a dose of 0.5 to 1 g/kg. Fluid therapy, aimed at correcting any hydro-electrolyte disorders, is also important. Always assess fetal viability by transabdominal ultrasound during treatment. In severe cases, if maternal hypoglycemia and ketonemia do not resolve, a cesarean section should be considered.

Prevention

- Food should be increased gradually by the same amount for the last 3-4 weeks of gestation (1.25-1.3 times of maintenance diet at the end of pregnancy).
- Proper nutrition is especially important for predisposed breeds with large litters.
- Nutrient-dense food should be fed in small amounts several times per day, as stomach volume is reduced in late gestation. Wet food may promote intake.
- Dams should gain 15-25% of their original body weight during pregnancy.
- Correcting the diet is a very important point: it should be rich in protein and energy. It should only be offered *ad libitum* if the dam is not eating enough to achieve the desired weight gain, or if there is a risk of pregnancy toxemia (previous occurrence).

ADVICE FOR BREEDERS ABOUT EQUIPMENT AND PREPARATION

In some situations, the dam may be unable to care for the newborns after whelping, so it is imperative that the breeder is prepared and able to provide first aid. Of course, whenever possible, it is advisable to let the mother look after her newborns, but it may be necessary to open the amniotic sac, break the umbilical cord, encourage licking and position them on her teats.

Key materials

Breeders should be informed of the key equipment they need to have in their facility, be trained in its use, have everything to hand and be prepared before the parturition.

1. Sucking out mucus that may obstruct the larynx (and nasal cavities): pediatric suction bulb **(Figure 1).**
2. Rubbing newborns to dry them and stimulate the cardiorespiratory system: *e.g.*, paper or hand towels.

Figure 1. Pediatric suction bulbs provide excellent suction and can be opened and cleaned afterwards.

A female (especially in cats) who is constantly moving her offspring has an environment that is not conducive to mothering. It is necessary to react quickly and prepare another site for her.

3. Ventilating the newborn in the event of hypoxia: mask on a one-way valve bag [AMBU bag **(Figure 2),** F_IO_2 (Fraction of inspired oxygen) 21% = ambient atmospheric F_IO_2] mouth-to-mouth, covering the whole muzzle (mouth and nostrils). It is advisable to show the breeders how to use it safely to avoid applying too much pressure *(e.g.,* only use thumb and ring finger to press on the balloon).

4. Ligating (Suture thread) and disinfecting the umbilical cord (tincture of iodine ideally).

5. Keeping warm: infrared lamp, hot water bottles, pediatric incubator >= 30 °C/86 °F at birth **(Figure 3).**

6. Giving a first milk feed to newborns if their mother cannot feed them. A commercial milk or colostrum replacer, formulated for puppies and kittens, is preferred. Of course, if the mother is lactating, it is always preferable to put the neonates on the dam. Pets benefits from colostrum ingestion in the first few hours of life (especially in the first 6 hours). You may consider having a colostrum/milk bank (mainly for dogs) with frozen samples.

It is important to observe maternal behavior at birth and make sure that the mother is not overstressed. Stress can lead to biting aggression and even eating the newborns.

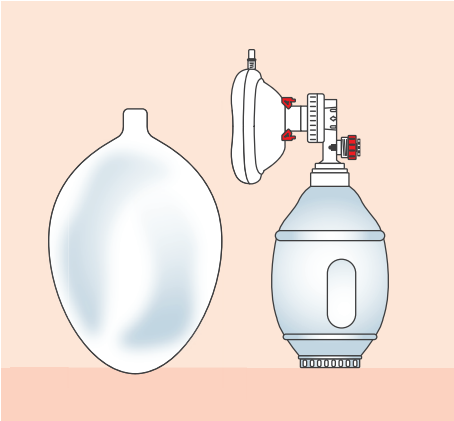


Figure 2. AMBU bag.

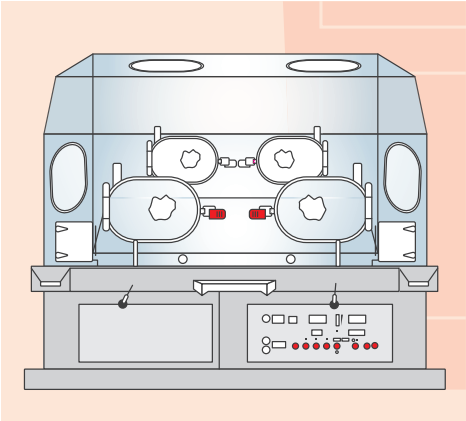


Figure 3. Pediatric incubator.

ROUTINE AND EMERGENCY ANTENATAL OBSTETRIC EXAMINATION

Complications during pregnancy (mainly at the end of gestation) and parturition can be anticipated thanks to a standardized obstetric examination of the female.

At the end of pregnancy, a female is a special patient. It is necessary to prepare for her arrival, often in an emergency, at the veterinary clinic, to ensure immediate care (emergency situation, stress limitation), away from other patients. In particular, she should not be kept waiting in the waiting room to avoid any risk of contamination by an infectious agent and to limit stress.

A range of complementary exams can help you make the right therapeutic decision: parturition without intervention, medically assisted parturition, cesarean section.

Female weight assessment

Obesity increases the risk of dystocia as it reduces the diameter of the birth canal (occupied by fat) but also the strength of uterine contractions (muscles covered in fat). Overweight queens are also associated with later obesity in offspring.

On the other hand, a thin body condition increases the risk of metabolic disease a few days before parturition (hypocalcemia, hypoglycemia).

Female body condition is known to have an impact on the health of the litter. Bitches overweight at mating have a 4-fold higher risk of perinatal mortality, while for overweight bitches at 4 weeks gestation, the risk is multiplied by 9.

Birth canal examination (from vulvar lips to vagina)

This is particularly important in primiparous bitches who have been inseminated (no natural mating). Vulvar or vestibular stenosis (septum or band **[Figure 1]**) may lead to obstructive dystocia. A digital examination in the 24 to 72 hours prior to delivery can also assess pelvic canal relaxation.

In brachycephalic breeds (Pug, English Bulldog, Staffordshire Bull Terrier, etc.), hyperplasia of the vaginal mucosa may (re)appear in the final week of pregnancy and obstruct the vaginal lumen.

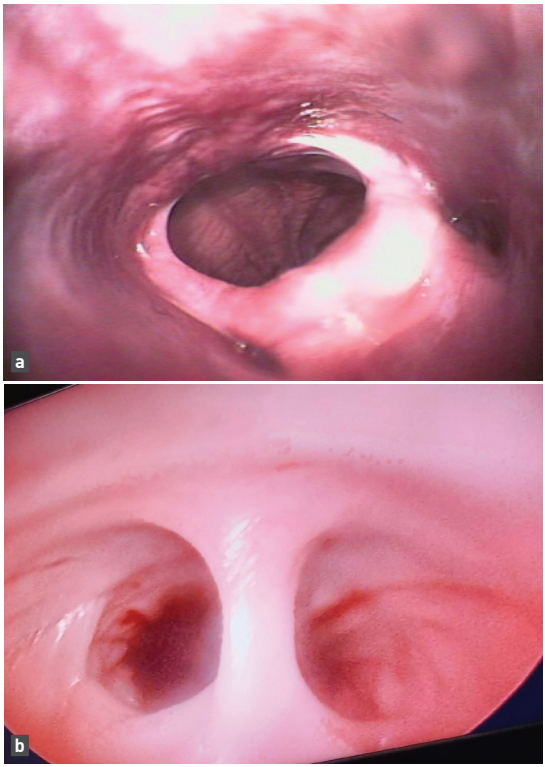


Figure 1.
Visual examination of the vaginal canal (speculum or vaginoscopy), with **(a)** normal vagina or **(b)** vestibular stenosis (vagina band).

Mammary tissue palpation

During the days of pregnancy, the bitch (more than the queen) is expected to show swelling of the mammary tissue. Milk secretion may only occur a few hours before or even after parturition. Nevertheless, some hypertrophy of the mammary tissue should be present.

If there is no enlargement in mammary tissue in the 5 days prior to parturition, it is wise to alert the owner, order a commercial milk and/or colostrum replacer, and if possible medically promote lactation.

Imaging examination

Trans-abdominal ultrasound (mandatory)

An ultrasound performed between 21 and 25 days post-ovulation confirms pregnancy, estimates the number of embryos and identifies resorptions. A large litter in a brachycephalic breed (English Bulldog in particular) should be monitored for intra-abdominal hypertension at the end of pregnancy. Conversely, the presence of a small litter size should prompt vigilance at parturition (single-puppy syndrome, maternal-fetal disproportion in miniature breeds).

In the final 15 days of pregnancy, ultrasound can help identify abnormalities that may affect parturition or neonatal survival: anasarca **(Figure 2),** fetal malformation and late fetal death **(Figure 3).**

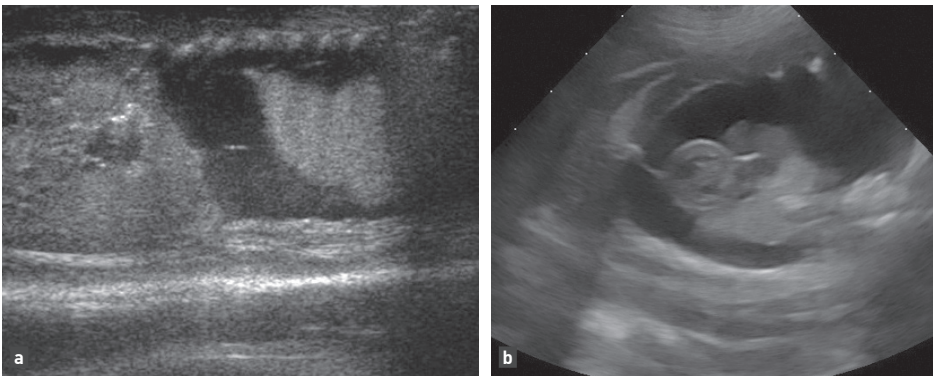


Figure 2. Anasarca: **(a)** note the presence of anechoic fluid in the thoracic cavity, with the lungs immersed in this fluid, **(b)** note the presence of subcutaneous fluid around the cranial cavity.

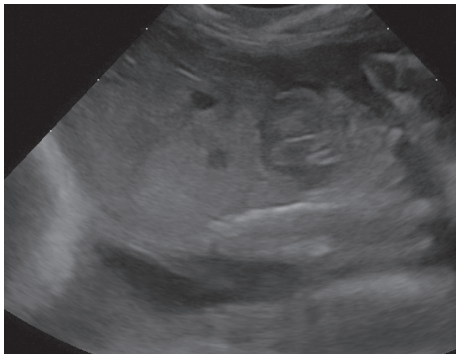


Figure 3. Late fetal death. Note the cardiac congestion with the presence of echogenic blood clots within the cardiac chambers.

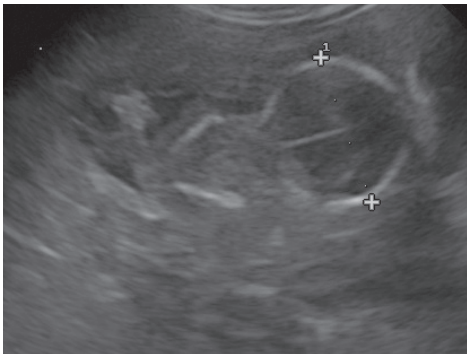


Figure 4. Measurements are taken on a longitudinal view of the skull. The cerebral hemispheres should appear symmetrical, and ideally both wings of the atlas should be visible.

Ultrasound allows several fetal measurements to be taken in order to define the estimated date of birth to within ± 1 day, in particular the biparietal diameter (BPD), the distance between parietal bones **(Figure 4).**

An ultrasound machine for emergency examination is sufficient. Ultrasound is the gold standard for assessing fetal distress by measuring the fetal heart rate **(Figure 5).** However, it is not reliable to determine malposition/malpresentation. For expert veterinarians, other anomalies may be identified: uterine torsion, fetal malformation, etc.

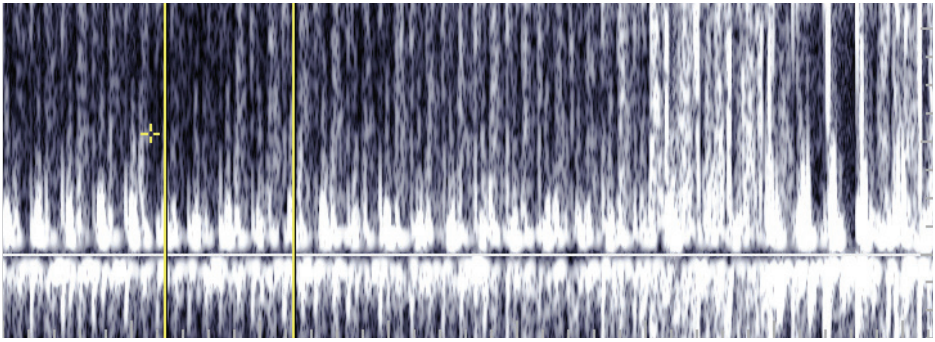


Figure 5. Heart rate measurement on a time motion view.

Abdominal X-ray (mandatory)

The main purpose of radiography is to determine the exact number of puppies/kittens to be born.

Radiography is the gold standard procedure for determining the number of remaining fetuses **(Figure 6)** and assessing the presence of fetal malposition **(Figure 7).**

The examination may also reveal the death of a fetus (presence of intrauterine gas, fetal bone collapse), but only after several hours **(Figure 8).**

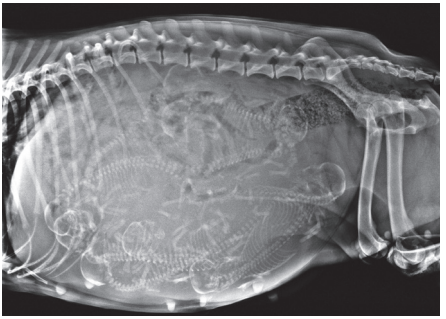


Figure 6. The profile view is often the most suitable for correct fetal counting. Start by counting the number of skulls, then assess the agreement with the number of columns.

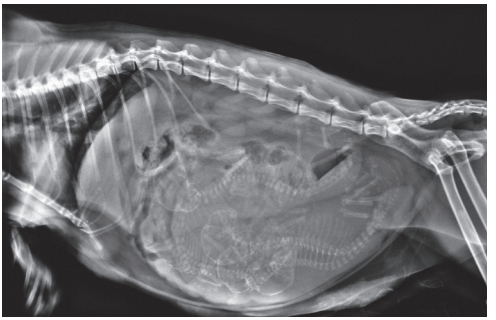


Figure 7. Malposition is observed by the presence of a fetus with its posteriors flexed and unable to turn over into a dorso-ventral position. The fetus died.

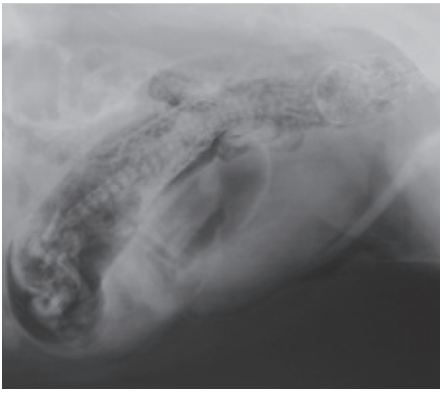


Figure 8. Fetal death with the presence of gas.

X-ray is recommended in the final week of pregnancy. An early X-ray often leads to fetal counting errors. A few X-rays at the end of pregnancy are safe for the fetus and the dam. Remember to ask the owner not to feed the female for 8 hours prior to the examination and to walk the bitch to limit the accumulation of feces in her colon. A full digestive system can interfere with an accurate fetal count.

In the case of malposition, the female often relaxes after a contraction phase and the fetus appears on the X-ray in the abdomen rather than in the pelvic canal. It is advisable to carefully examine the position of the limbs and neck to ensure that there is no malposition.

The assessment of maternal-fetal disproportion by radiographic measurements is not very reliable due to the lack of data among breeds. Indices have been suggested for only two breeds (Boston and Scottish Terriers) in a small number of dams. Only very severe disproportion (fetal malformation, pelvic bone callus) can be diagnosed with certainty – and only in the final days of pregnancy.

Biological examinations

Blood progesterone (advisable)

Progesterone measurement (quantitative and semi-quantitative) is used to determine whether the female is ready to give birth. In a situation of suspected dystocia, this is rarely necessary, except in the case of single-puppy syndrome.

Biochemistry

Blood and urine tests can help identify any metabolic disease: hypoglycemia, hypocalcemia, ketoacidotic diabetes. Various metabolic disorders can affect the pregnant female. Simple tests can be used to diagnose them:

- Urine dipstick: glycosuria in gestational diabetes in the bitch. Ketone bodies in case of ketoacidotic diabetes.
- Blood chemistry: hypoglycemia, hypocalcemia (ionized calcium is preferred to a corrected calcium assay).

RECOMMENDED EQUIPMENT FOR PARTURITION AT THE CLINIC

Immediate care consists of preparing the examination room (clean and quiet), having complementary investigations available (ultrasound, X-ray), preparing the surgery room for a possible C-section, and providing a heated place for newborns until they return home with their mother. A pre-prepared parturition unit (with a specific checklist) allows us to be more efficient and organized.

Equipment recommended for management of the mother

It is highly recommended to have gaseous anesthesia when performing a cesarean section. Although it is possible to maintain injectable - only anesthesia, endo-tracheal intubation is always mandatory in the case of C-section.

Mandatory equipment and medication

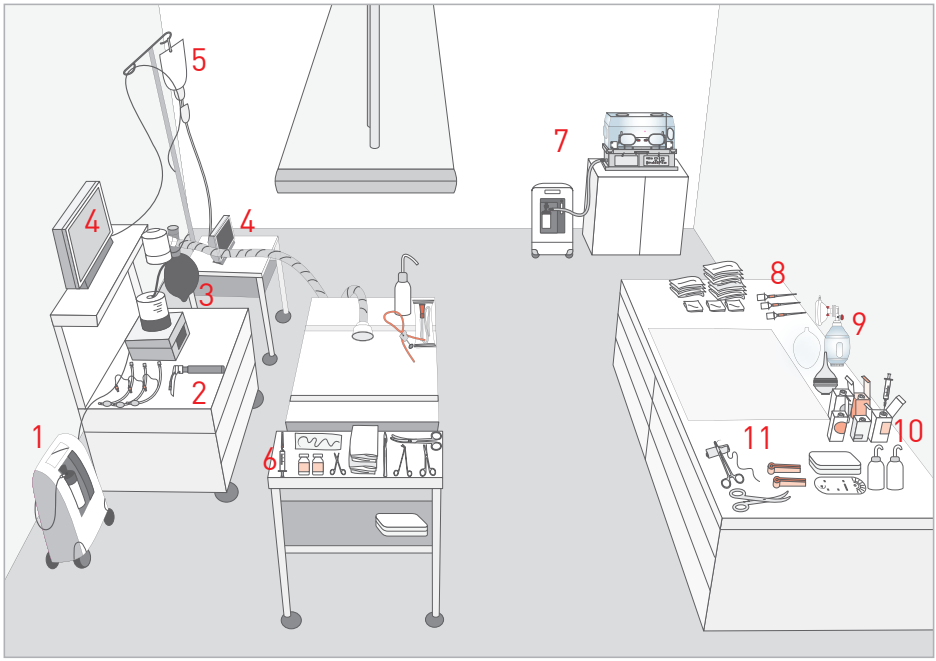
- Endotracheal tube suitable for the dam's size (improve oxygenation, reduce risk of obstructed airway, pneumonia)
- Catheters (for perfusion and emergency injection)
- "Standard" surgical instruments
- Sutures adapted to the closure of the uterus:
  - small diameter absorbable monofilament *(e.g.,* PDS®, Monocryl® 3-0)
- Ringer's lactate solution (perfusion and reduce metabolic acidosis)
- Alfaxolone or propofol (gold standard drug for anesthesia induction)
- Xylocaine spray (reduce laryngeal spasm at time of intubation)

Recommended equipment

- Gas anesthesia (isoflurane or sevoflurane)
- Atraumatic forceps:
  - Doyen intestinal, Debakey forceps (for episiotomy procedure)
- Anesthesia monitoring equipment:
  - oximeter/capnograph, venous blood pressure measurement, ECG

Recommended medications

- Maropitant or/and metoclopramide injectables (prevent vomiting and promote lactation)
- Oxytocin (uterine contractions after delivery)
- Calcium injectable (in case of hypocalcemia)
- Dexamethasone (to reduce laryngeal edema in brachycephalic breeds, etc.)
- Methylergometrine, etamsylate (in case of hemorrhage at the end of the C-section)
- Analgesics:
  - methadone (systemic), bupivacaine/lidocaine (abdominal wall infiltration)



1 Oxygen concentrator **2** Endotracheal tube and laryngoscope **3** Gas anesthesia equipment **4** Anesthesia monitoring equipment **5** Ringer's lactate solution **6** Surgical instruments **7** Incubator with oxygen supply **8** Resuscitation equipment **9** Equipment for suctioning and ventilating newborns and disinfection solution for cords **10** Disinfection solution, sterile surgical drapes, sterile gloves, medicines **11** Sutures for tying cords, clamps (for clamping cords), round-tipped scissors.

Recommended equipment for management of the newborn

Mandatory equipment

- Suction system for laryngeal mucus:
  - *e.g.*, pediatric suction bulb
- Wipes (paper or hand towels) for rubbing and drying the neonate
- Thread for tying umbilical cords:
  - suture material or thread
- Round-tip scissors for cutting umbilical cords
- Iodine tincture (preferable) or betadine solution to disinfect umbilical stumps

Recommended equipment

- For newborn oxygenation:
  - Open circuit oxygen concentrator + mask (> 4 L/min., < 12 mmHg) for oxygenating hypoxic and/or sedated newborns
  - Mask on one-way valve bag (AMBU bag, F_IO_2 21% = ambient atmospheric F_IO_2: insufficient in severe respiratory distress): 40-60 rpm for 30 seconds then 12-20 rpm
- For cardio-respiratory stimulation:
  - doxapram, one drop sublingually only if oxygen supply is available, acupuncture needle (GV26 stimulation point)
- Warm and clean nest:
  - Clean cage with infrared lamp, heating mat, hot water bottle
  - Incubator (30 °C/86 °F, add hot water bottle if < 3 puppies)

Well-trained staff and a well-prepared room with at hand equipment and materials are the basis of an effective intervention. The use of a checklist will help secure the overall organization. At this critical time every minute is precious.

PARTURITION

HOW TO DETERMINE THE DATE OF PARTURITION

Precise determination of the date of parturition enables human assistance to be planned at the time of birth, thus reducing the risk of stillbirths. Various parameters can be used as a reference: at ovulation, during pregnancy or at the approach of parturition.

Around ovulation

Day of LH peak. LH is assayed in blood, once a day, by semiquantitative testing or is indirectly identified via a progesterone concentration of ~6 nmol/L (~2 ng/mL). Parturition occurs between 62 and 68 days after the LH peak (90% of the bitches whelp between 63 and 67 days).

Day of ovulation. If the day of ovulation is precisely determined by blood progesterone assay and/or ovarian ultrasonography, parturition is expected after 58 to 68 days in the bitch (80% of bitches whelp between 61 and 65 days after ovulation). In the case of an elective C-section, only this reference date allows precise scheduling.

Day(s) of mating. In the bitch, there is great variability in the time between the day of mating and parturition which makes it impossible to use it to determine the date of whelping. In the female cat, parturition occurs 60 to 70 days after mating (for 85% of the females).

First day of diestrus. In vaginal cytology, around 2-5 days after ovulation, cell populations change from an estrus to a diestrus pattern. A 20% decrease in the proportion of superficial keratinized cells, with the appearance of parabasal cells and neutrophils, defines the first day of diestrus; whelping occurs between 54 and 60 days after (90% of bitches whelp between 56 and 58 days after the first day of diestrus).

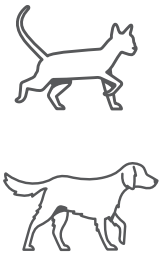
During pregnancy

During pregnancy, the appearance of specific features on ultrasound examination can provide information on the number of days post-ovulation or before parturition **(Table 1).**

Table 1. Date of first ultrasonographic visualization in the canine embryo/fetus.

Organ/structure	Date of first appearance
Heartbeats	21-23 DPO
Fetal movements	32-34 DPO
Abdomen/thorax distinction (contrast lung/liver)	34-36 DPO
Stomach	29-37 DPO
Kidney corticomedullar differentiation	20-16 DBP

DPO – days post-ovulation, DBP – days before parturition.



Formulas based on ultrasonographic measurements can also be used to assess either the stage of pregnancy or the number of days until parturition **(Tables 2 and 3).** Until ~35 days of pregnancy, dimensions of the embryonic vesicles are measured as two perpendicular diameters: ideally on a minimum of 3 vesicles, and the mean diameter is calculated **(Figure 1).** After ~35 days of pregnancy, fetal dimensions are measured, *i.e.,* biparietal and/or abdominal diameters, on a minimum of 3 fetuses **(Figure 1).** Other measurements have also been proposed to calculate the date of parturition but they are less easy to measure and/or less precise.

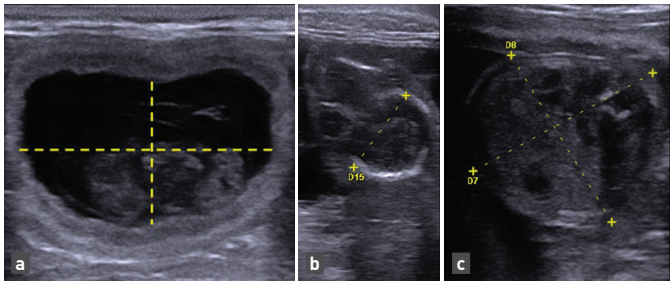


Figure 1.
(a) Inner chorionic cavity.
(b) Biparietal diameter: distance between the two parietal bones on a section where eyes are visible.
(c) Body diameter: at the widest point, with the stomach visible, and ideally at the abdominal insertion of the umbilical cord.

Table 2. Dogs: calculation of the date of parturition based on fetal biometrics on ultrasound examination (non-exhaustive list of available equations).

Early pregnancy	• All sizes, non-brachycephalic DBP = (66.3384 + 0.1767 x W kg - ICC mm)/1.5151 • Miniature breeds Maltese Terrier: DBP = 63.2 - (18.58 + 0.71 x ICC mm) Yorkshire Terrier: DBP = 63.4 - (18.92 + 0.65 x ICC mm) • Large breeds DBP = (105.1 - ICC mm)/2.5 German Shepherd: DBP = 44.76 - (4.34 x ICC mm) Golden Retriever: DBP = (84.66 - ICC mm)/1.86
Late pregnancy	• Miniature breeds Maltese Terrier: DBP = 32.6 + 0.73 x BD mm Yorkshire Terrier: DBP = 32.9 + 0.75 x BD mm • Small breeds All DBP = (25.11 - BP mm)/0.61 Small size - Brachycephalic DBP = 36.34 - 13.49 x BP cm Small size - Non brachycephalic DBP = 40.72 - 15.25 x BP cm • Medium breeds DBP = (29.18 - BP mm)/0.7 DBP = 65 - [(7 x BD cm) + 29] DBP = 65 - (22.89 + 12.75 x BD cm - 1.17 xBD² cm) • Large breeds DBP = (30 - BP mm)/0.8 DBP = 39.20 - 12.95 x BP cm German Shepherd DBP = 38.65 - 12.86 x BD mm Golden Retriever DBP = (31.9 - BP mm)/0.8 • Giant breeds DBP = (29.06 - BP mm)/0.67

DBP – Number of days before parturition, W – Weight of the female, ICC – Inner chorionic cavity, BD – Body diameter, BP – Biparietal diameter.
Miniature < 5 kg/11 lbs; small 5-10 kg/11-22 lbs; medium 11-25 kg/24-55 lbs; large 26-40 kg/57-88 lbs; giant > 40 kg/88 lbs.

Table 3. Cats: calculation of the date of parturition based on fetal biometrics on ultrasound examination (non-exhaustive list of available equations).

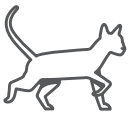
Early gestation	• Large breeds (4.5 - 7.5 kg) Maine Coon: DBP = 57.9 - 0.79 x ICC mm
Late pregnancy	• All sizes DBP = (23.39 - BP mm)/0.47 DBP = 42.19 - 1.01 x BD mm DBP = (35.1042 - BD mm)/0.42 DBP = 43.5 - 10.9 x BD cm • Large breeds (4.5 - 7.5 kg) Maine Coon: DBP = 49.3 - 1.86 x BP mm

DBP – Number of days before parturition, ICC – Inner chorionic cavity, BP – Biparietal diameter, BD – Body diameter.

Late in pregnancy (a few days before parturition)

- Behavioral changes (restlessness, nesting) and the onset of milk production are not indicative of impending parturition (they may occur as early as 15 days before parturition or, on the contrary, be absent).
- Radiographs do not allow any precise dating.

- In dogs, a blood progesterone concentration below 6.36 nmol/L (2 ng/mL) indicates that whelping is expected within the next 24 hours. Conversely, a concentration greater than 6.36 nmol/L (2 ng/ mL) does not exclude that whelping will occur within a 24-hour period.
- In 80% of preparturient bitches, whelping is preceded by a rectal temperature drop. A baseline is established by rectal temperature measurement 3 times per day (morning before any effort immediately at wake up, mid-day and evening). A drop > 1° C/2 °F from this baseline indicates that whelping is expected within the coming 24 hours.



- Neither blood progesterone assay nor rectal temperature are reliable in the queen.

Beware that:

- The equations are species-specific; some have been calculated for breed sizes (in dogs) and even for certain specific breeds.
- The accuracy of the calculations decreases with the advancement of pregnancy.
- The calculation provides an approximate date but does not change the intrinsic variability of pregnancy length: it is advisable to use several equations (adapted for breed or breed size) and to indicate that 65% of parturitions occur within ±1 day of the calculated date, and around 80% within ±2 days.

ALERT CRITERIA FOR DYSTOCIA

If at least one of the criteria listed below is present, owners are advised to take the parturient female to a veterinary practitioner for a clinical examination. This list of criteria can be provided to the veterinary nurse as a checklist for anxious owners phoning the clinics.

Stage of pregnancy

- In dogs, more than 63 days have elapsed since ovulation, more than 72 days after mating.
- In cats, more than 70 days have elapsed since mating.

Rectal temperature drop

- In dogs, if more than 24 hours elapse without any sign of parturition, or if the rectal temperature returns to baseline without any sign of parturition.

Maternal health status

- Hyperthermia (rectal temperature > 39.5 °C/102.2 °F).
- Anorexia or restlessness for more than 24 hours.
- Acute abdominal pain.
- Any sign of shock, respiratory distress.

Vaginal discharge

- Hemorrhagic at any stage of the parturition.
- Abundant greenish discharge before the expulsion of the first fetus.
- Greenish (in dogs) or brown-red (in cats) discharge not followed by a fetal delivery within 1-2 hours.
- Amniotic/allantoic fluid (abundant aqueous liquid) not followed by a fetal delivery within 1 hour.
- Allantochorion (placental pouch) visible but not followed by a fetal delivery within 1 hour.

The decision criteria listed here are associated with an increased risk of stillbirth, although stillbirth is not systematic in the presence of these warning signs. However, stillbirth can occur even in the absence of these warning signs.

Abdominal contractions

- More than 30 minutes (bitch) or 5 minutes (queen) of intense abdominal contractions not followed by the delivery of a newborn.
- Weak and irregular abdominal contractions for more than 2 hours.

Intervals

- The interval since delivery of the last fetus is over 2 hours in dogs. In cats, parturition can be interrupted for hours making it difficult to determine a critical delay; as a rule of thumb, the same "2 hours" delay is used in practice.
- Time elapsed since expulsion of the first fetus greater than 24 hours.

Fetal health status

- Fetus present in the birth canal for more than 1 hour.
- Birth of a stillborn fetus.
- Fetus blocked in the pelvic canal.

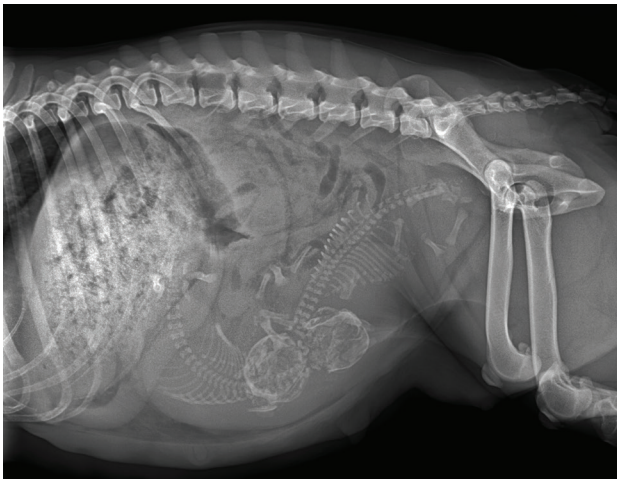


Figure 1. Prepartum radiographs can be used to determine the number of fetuses, enabling early detection of at-risk parturition (one or two fetuses or, conversely, a large litter).

Only a veterinary examination can determine the degree of urgency of the parturition for mother and fetuses. In addition to the clinical exam, certain imaging techniques, such as ultrasound or X-ray, can help in the decision-making process **(Figure 1).**

For a more detailed assessment of the situation and potential therapeutic approaches, refer to the following species-specific "Obstetric management decision trees" chapter.

OBSTETRIC MANAGEMENT DECISION TREES

Managing a parturition is often stressful for both the breeder and the medical staff. Here, we have detailed three decision trees to help clinicians make the right choices at the right time.

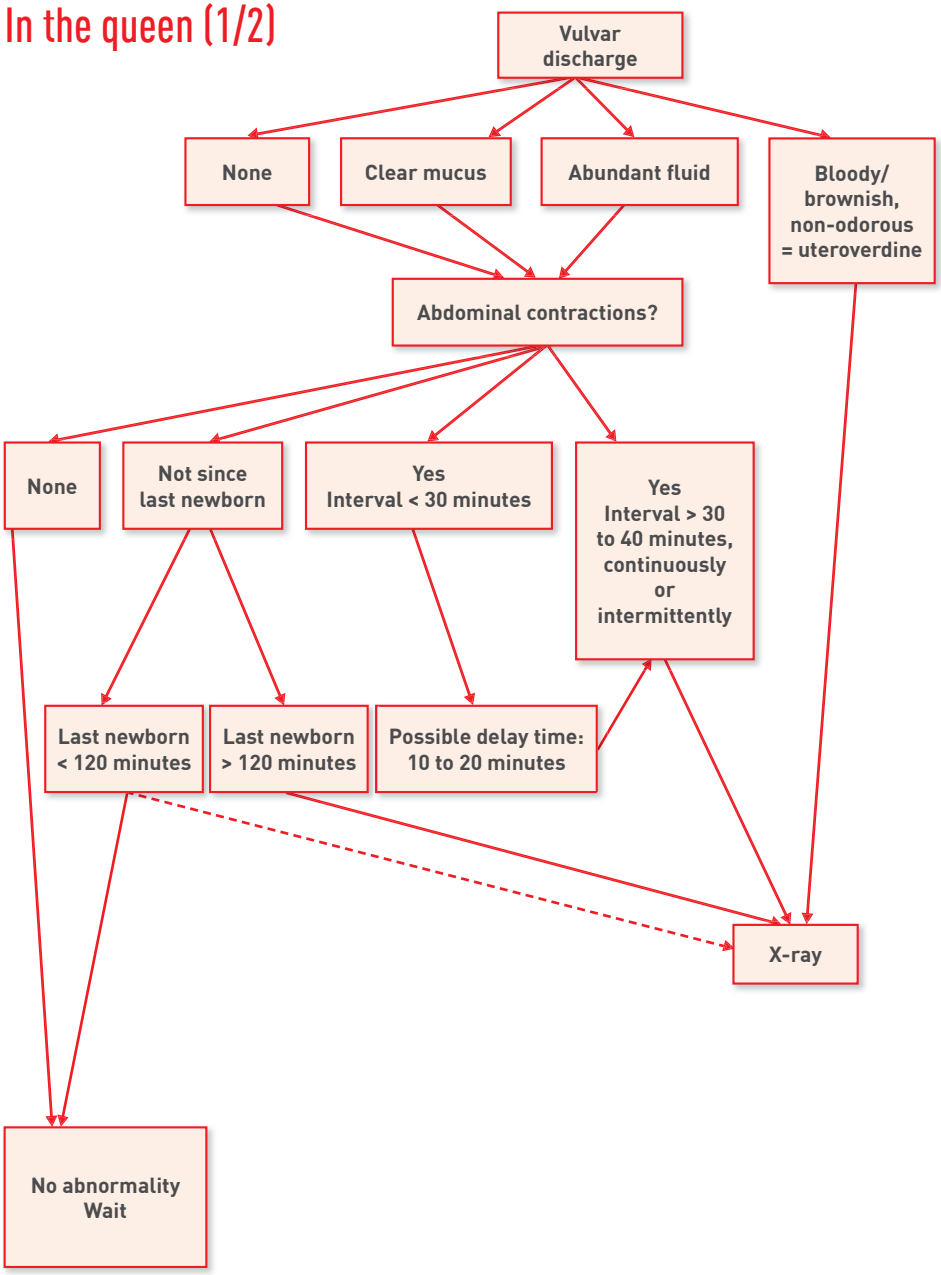
Three species-specific decision trees

In this section we have detailed species-specific decision trees to guide the veterinary team in assessing the next course of action and the urgency of the situation.

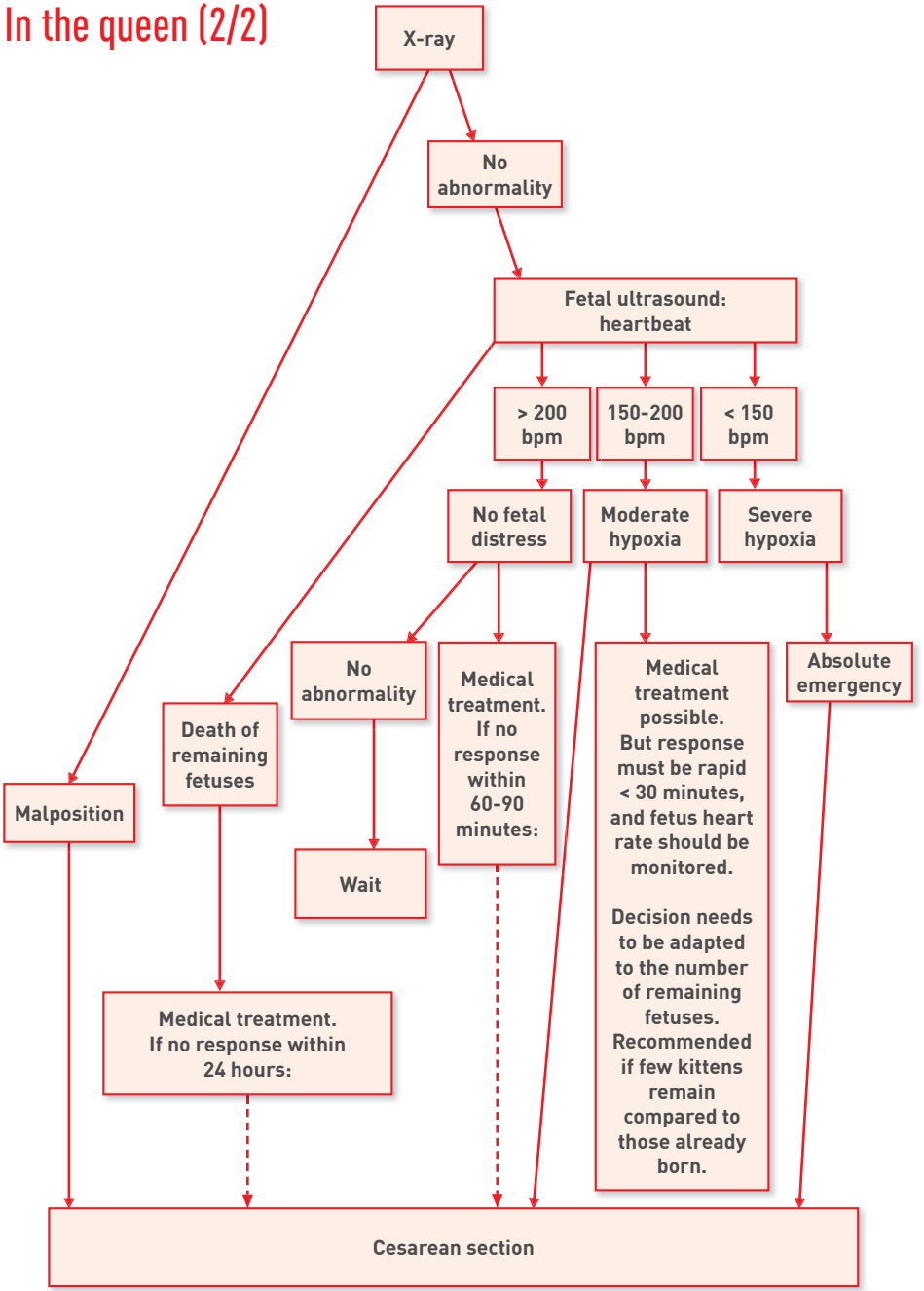
We have also addressed the specific case of the single puppy in the bitch, which requires special attention.

This tool is designed to guide the clinician through a series of questions such as: when to worry? When to bring the patient in? Which tests to choose and how to interpret them? When to decide on medical treatment? When should a cesarean section be performed?

In the queen (1/2)

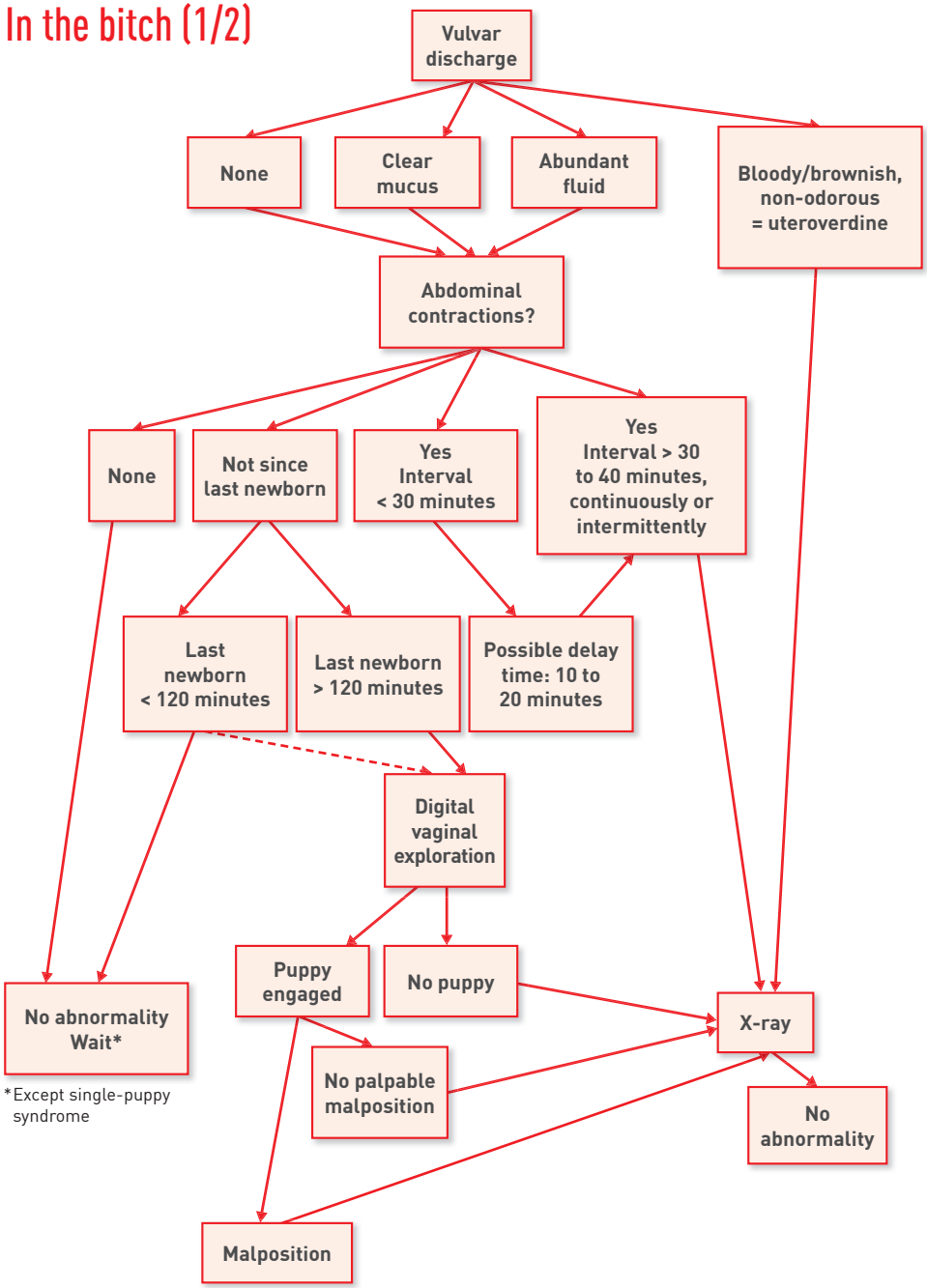


In the queen (2/2)

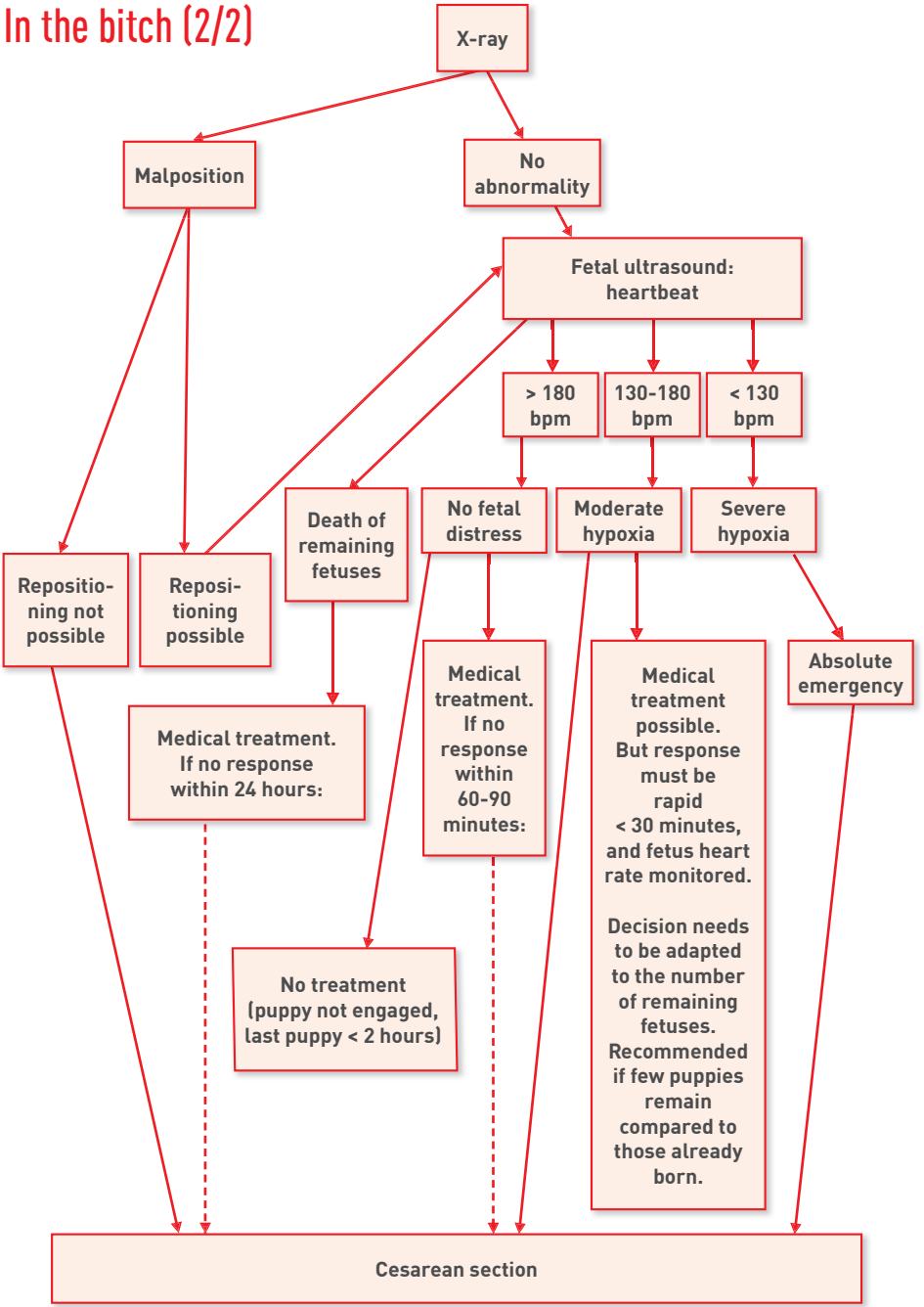


bpm – beat per minute.

In the bitch (1/2)

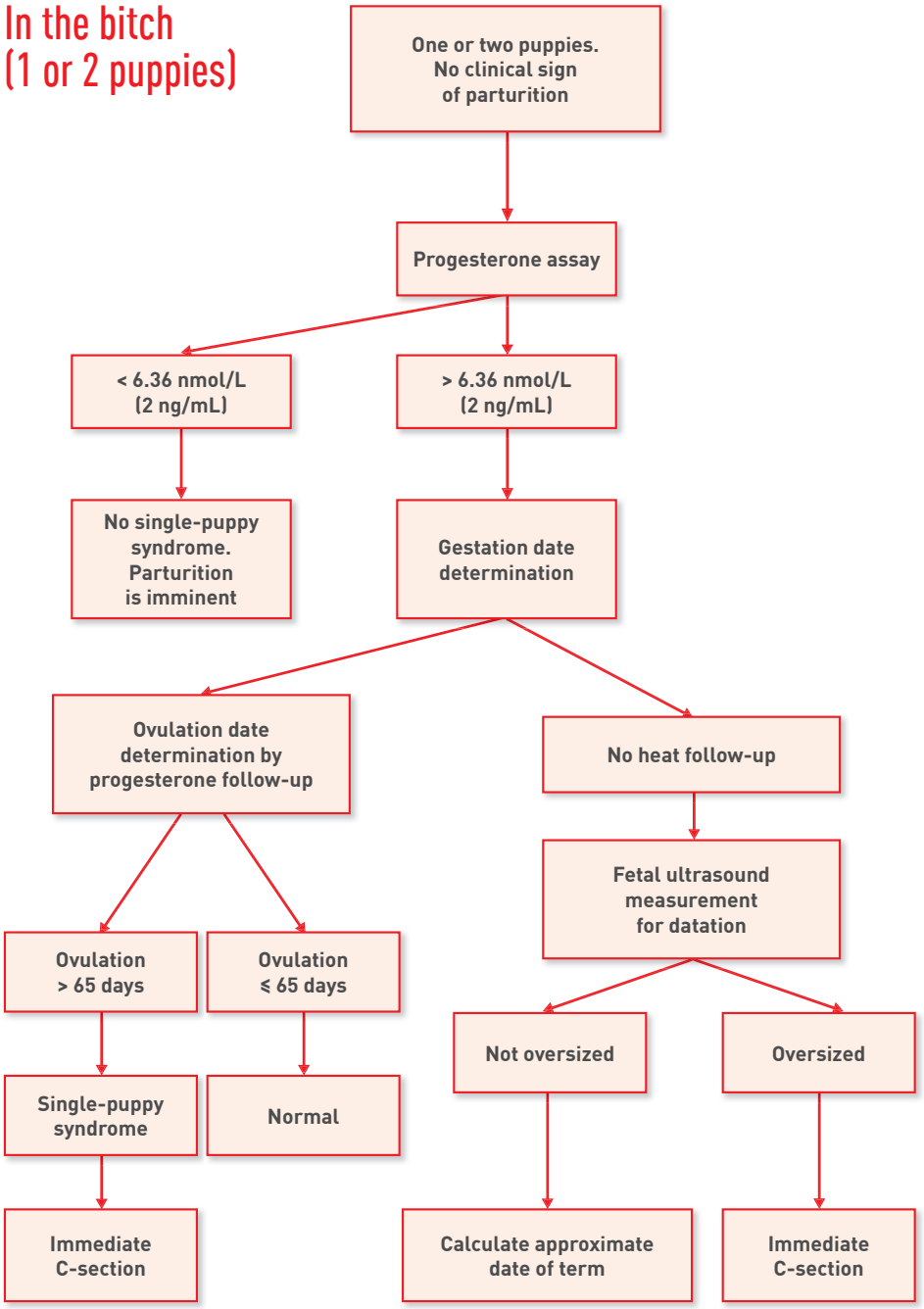


In the bitch (2/2)



bpm – beat per minute.

In the bitch (1 or 2 puppies)



MEDICAL MANAGEMENT OF DYSTOCIA

Before deciding to start any medical treatment, it is very important to make sure that there are no contraindications. The use of calcium and/or oxytocin can be both useful and harmful if misused. Calcium can induce severe cardiac arrhythmia and oxytocin can cause uterine rupture if used in obstructive dystocia.

Conditions required for the medical management of dystocia

1. Animal is in good health/good general condition.
2. No obstruction.
3. Dilated cervix (in practice, if at least one fetus has been expelled).
4. No fetal suffering (normal heart rate).
5. Maximum of 3 remaining fetuses (the number is subjective, but authors agree that medical treatment should not be conducted if too many fetuses remain).

It is also important to check for the presence of the Ferguson reflex (vaginal palpation should induce a strong uterine contraction). Its absence could be a sign of uterine exhaustion and a good argument in favor of C-section.

The faster fetuses are born, the better their chances of survival; neonatal mortality increased from 5.8% between 1 and 4.5 hours of effort to 13.7% in bitches whose treatment was initiated 5 to 24 hours after the onset of labor.

Medical management of dystocia

Ionized calcium and glucose should always be measured prior to treatment.

If all parameters are within normal values, the first treatment to try is oxytocin injection. If administered at the same time as calcium, oxytocin will have a greater impact.

After 3 injections of oxytocin without success or if signs of fetal suffering are observed at any moment of treatment, a decision to perform a C-section should be taken.

Glucose (bolus if needed or infusion)

Calcium (bitch only): Calcium gluconate 10% (0.465 mEq Ca2+/mL)

- 0.5-1.5 mL/kg
- 1 blister in a 250 mL 5% glucose solution, then infuse
- 5-20 mL/kg/h
- Cardiac monitoring of the bitch

Oxytocin

- Bitch: 0.15 IU/kg IV/IM/SC; never exceed 5 IU/injection or 20 IU/total treatment
- Queen: 1 IU/injection
- 3 times 30 min apart

After each injection, the animal should be walked and previously born puppies/kittens encouraged to suckle to induce endogenous oxytocin production. Honey or jam can be spread on the dam's gums to provide some energy.

Fetal heartbeat must be monitored very regularly by ultrasound **(Figure 1).**

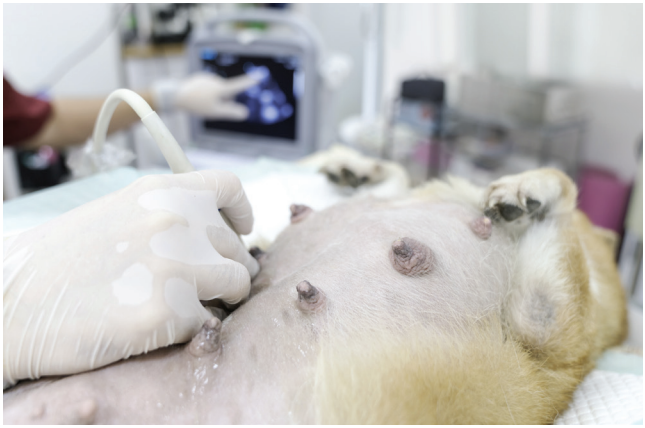


Figure 1. Ultrasound examination of a bitch to assess fetal heart rate and detect signs of fetal distress.

ABOUT THE ELECTIVE CESAREAN SECTION

The decision to proceed with an elective cesarean section (C-section) can be a difficult one to make, even if it is obvious in some cases. An elective C-section is performed before the onset of parturition and before labor has started. This means that the dam will not experience parturition, that the newborn will not pass through the birth canal, and that can have some consequences.

Pros and cons of performing an elective C-section

Pros	Cons
Bitch or queen known for having difficulties with parturition	Ethical issues
No fetal distress (less difficulties with resuscitation compared to emergency C-section)	Surgery and anesthesia concerns
Less risk of uterine rupture compared to emergency C-section	No immediate maternal behavior (mother not fully awake)
Safer anesthetic procedure compared to emergency surgery	Post-surgical pain (decreased maternal behavior and/or milk production)
Elective = during normal hours, no rush, full team	Cost

Performing an elective C-section will protect the dam from complications associated with prolonged parturition or emergency surgery. Planned C-sections also reduce fetal distress and the risk of neonatal mortality. However, it is important that this surgery does not become a procedure of convenience and that it is reserved for cases presenting a risk of dystocia.

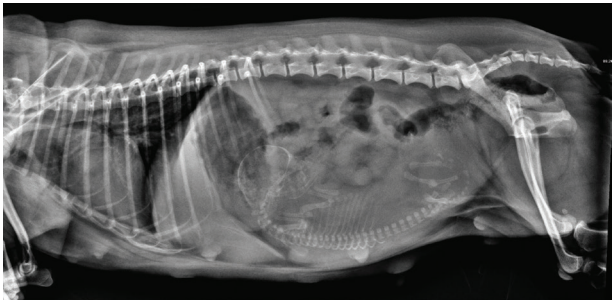


Figure 1.
X-ray of a single puppy.

Which bitches and queens are at risk of dystocia?

- History of previous dystocia or long-lasting labor (leading to hypoxic newborns).
- Defect of the birth canal.
- Breeds: brachycephalic, giant and miniature breeds in dogs, British Shorthair, Birman and Oriental breeds in cats.
- Single-puppy syndrome **(Figure 1).**
- Large litters.
- In bitches: primiparous dams older than 6 years.

What is the impact on the newborns?

Neonatal mortality rates were compared between the different kinds of birth (natural, emergency C-section and elective C-section). It is now recognized that the chances of survival are higher if the C-section is scheduled than if it is performed during dystocia. However, compared with natural whelping, APGAR scores for newborns are generally lower after C-section but usually reach a normal level after a few minutes. This can have an impact on the first few days of life.

The APGAR scoring system is an easy and reliable method for evaluating both human and animal neonates. The following criteria are evaluated:

- **A**ppearance of the mucosa
- **P**ulse
- **G**rimace (reflex irritability)
- **A**ctivity
- **R**espiration

It was long thought that the amniotic sac was a sterile chamber, and that the microbiota of newborns was transmitted through the birth canal. Recent studies have highlighted the fact that bacteria can invade the fetal gut via the placenta. The meconium microbiota of puppies born naturally or by elective C-section is very similar.

HOW TO DETERMINE THE OPTIMAL MOMENT FOR AN ELECTIVE C-SECTION

Once the decision has been made to proceed with an elective C-section, it's essential to determine the optimal timing for both mother and newborn.

In the bitch

When scheduling a C-section, two methods are possible for a bitch:

1) Elective C-section (the conventional way): wait for progesterone drop, act when the bitch is at term but before labor.

Progesterone drop is defined as blood progesterone levels below 6.36 nmol/L (2 ng/mL) with reference assays (RIA – radioimmunoassay – and CLIA – chemiluminescent immunoassay). Values may vary if you use different assays.

It should be noted that in the case of single-puppy syndrome in large breeds, the drop may not occur before fetal distress and death. In such cases, if the ovulation date is known, a planned C-section can be performed. Otherwise, it will be necessary to assess fetal vitality by ultrasound exam twice a day around the estimated parturition date.

Here are a few key points to help you determine the preferred date:

1. Detection of ovulation during the estrus cycle.
2. Pregnancy follow-up: use fetometry to estimate the date of parturition. In animals whose ovulation date is unknown, luteal insufficiency can complicate the natural drop in progesterone in bitches close to parturition. Having an approximate date of birth helps avoid confusion.

3. Monitor the bitch's rectal temperature (RT) four times per 24h starting from the 5th or the 7th day before the due date and until the drop is observed. The RT drops 1 °C/2° F in around 80% of bitches 12 to 36h before parturition. If the drop is observed, a progesterone assay must be performed.
4. Monitor blood progesterone levels once a day, in the afternoon, starting 2 to 3 days before the due date to avoid missing the drop or even earlier if a drop in rectal temperature has been observed.

2) Planned C-section induced with aglepristone: intervene when the bitch is not at term, but only proceed if the ovulation date is known with certainty. Although this medical treatment is off-label, several articles have been published on the subject.

If induction with aglepristone is possible, here are a few steps:

- Wait until the 61st day after ovulation.
- If blood progesterone levels have dropped, proceed immediately with a C-section.
- If progesterone levels have not dropped: check milk production (do not operate on a bitch with no milk), ultrasound examination of the fetuses (heartbeats, ultrasound maturity criteria).
- If the female is already producing milk and the fetuses are healthy, induction can be performed:
  - Injection of 15 mg/kg subcutaneously in the late afternoon (around 6 pm).
  - C-section planned the next morning (around 10 am).

In the queen

Scheduling a C-section is no simple matter in cats. Pregnancy length is more variable (average of 65 days after mating but ranges from 60 to 70 days) and some queens go into labor without showing a drop in progesterone. Fetometry should be used to estimate the date of kittening, and fetuses should be monitored by ultrasonography to assess signs of maturity. Any sign of fetal distress near the estimated parturition date should trigger a C-section.

ANESTHESIA AND ANALGESIA FOR C-SECTION

The anesthetic plan for dogs and cats undergoing C-section is mostly affected by changes in maternal physiology and concerns about fetal vitality. C-sections are commonly performed as emergencies out-of-hours; both puppy and maternal mortality are higher in emergency situations than during planned C-sections.

Specificities of gestating animals

It is important to emphasize that drugs rapidly cross the placental barrier and potentially reach high concentrations in the fetus once general anesthesia has been induced. Consequently, the anesthetic protocol will have a major influence on fetal vitality **(Table 1),** which is determined by placental transfer ratio of the drug.

Overall, the anesthetic plan should take into account short-acting drugs that can be antagonized as well as balanced anesthetic techniques *(i.e.,* epidural administration of local anesthetics) that will reduce volatile anesthetic concentrations, thus minimizing fetal and maternal cardiorespiratory depression.

In practice, several studies have investigated the morbidity and mortality of different anesthetic protocols, mainly in dogs. **Box 1** suggests a step-by-step approach and an anesthetic plan for dogs and cats undergoing C-section.

These drug protocols should enable dams to be ready to care for their newborns soon after the end of anesthesia. Patients can also be sent home quickly to avoid nosocomial infections.

Table 1. Most important changes in maternal physiology impacting anesthetic management of dogs and cats undergoing C-section. The information is based mainly on data from women and experimental models.

System	Physiological changes	Anesthetic management
Cardiovascular	• ↑ Oxygen consumption, metabolic demands, cardiac output (up to 40%), heart rate (up to 50%) • ↓ Blood pressure and systemic vascular resistance • ↑ Blood volume (20-30%) and plasma volume with potential relative anemia	• Increased risk of hypoxemia and hypotension during anesthesia • Blood pressure monitoring is crucial to avoid decreased fetal oxygen delivery/blood flow during hypotensive states, especially if hemorrhage is present • Dehydration should ideally be treated before anesthetic induction with the administration of crystalloids
Respiratory	• ↑Tidal volume, respiratory rate and minute ventilation (up to 60-70%) • ↓Functional residual capacity	• Limited oxygen reserves • Increased risk of desaturation and hypercapnia; preoxygenation before anesthetic induction strongly recommended • Capnography helps monitor and prevent respiratory depression, and provides a means of adjusting ventilation.
Gastrointestinal	• ↑Uterus size • ↓Esophageal sphincter pressure and gastrointestinal motility	• Perform rapid intubation to protect airways • Increased gastric pressure with risk of regurgitation and gastroesophageal reflux • Reduce the volume of local anesthetics used for epidural anesthesia
Central nervous	• ↑Concentrations of progesterone and endorphins	• Decreased anesthetic requirements; doses and volatile anesthetic concentrations should be adjusted accordingly

Box 1. A step-by-step approach and anesthetic protocol for dogs and cats undergoing C-section.

- Perform a full physical examination and determine fetal vitality and status (the fetal heart rate should be higher than 200 bpm).
- Use feline-friendly interactions and fear-free techniques throughout the process.
- Apply a local anesthetic cream (EMLA cream) to the cephalic vein, occlusive dressing and bandage; onset of action may take up to 20 minutes. This technique is used to desensitize the skin before venous catheterization, as sedation is often avoided in these patients, as drugs can affect fetal vitality.
- Introduce a venous catheter and start the administration of fluid therapy, especially if the patient is dehydrated; a balanced isotonic crystalloid such as lactated Ringer's can be used at 5 mL/kg/hour. A fluid bolus of 5-10 mL/kg over 15 minutes can be administered prior to anesthetic induction if the patient requires it.
- Preoxygenate; if the patient is cooperative, the abdomen and epidural space can be shaved.
- If the patient is cooperative, monitor ECG and blood pressure using the oscillometric or Doppler method to obtain a baseline reading before induction of general anesthesia.
- Anesthetic induction can be performed with either propofol (5-8 mg/kg) or alfaxalone (2-3 mg/kg) IV. Drugs should be given to effect. High doses are often required with this approach when patients have not been premedicated. These drugs have relatively rapid clearance from the maternal and fetal plasma, making them suitable anesthetic options.
- After endotracheal intubation and placement of anesthetic monitoring, perform lumbosacral epidural anesthesia with preservative-free lidocaine (0.1 mL/kg) and morphine (0.1 mg/kg); these injection volumes have been reduced by 50% for pregnant patients.

- If an epidural is not performed, the patient may be given a low dose of methadone (0.2-0.3 mg/kg) slowly by IV before induction of anaesthesia. In this case, an incisional (line) block with lidocaine (up to 5 mg/kg) can be performed prior to surgical incision. Otherwise (with an epidural block), methadone can be administered to the dam once the fetuses have been removed during surgery. Opioids are either avoided during surgery, as described above, or antagonized with sublingual naloxone, as respiratory depression can be life-threatening for the newborn.
- Maintenance is performed with a volatile anesthetic (isoflurane or sevoflurane); these anesthetics are rapidly cleared when the newborns are breathing; maintenance with injectable anesthetics is not recommended due to drug accumulation reducing fetal viability and prolonging anesthetic recovery.
- Sublingual naloxone should be used to antagonize the effects of methadone on the newborns when an epidural has not been used.
- The use of non-steroidal anti-inflammatory drugs during C-sections is controversial, as fetal exposure to these drugs via milk could have an impact on organ maturation; the author routinely administers a single dose of these drugs to the dams postoperatively as they are important as part of multimodal analgesia.
- Note: drugs such as benzodiazepines (midazolam or diazepam), ketamine and barbiturates have been shown to increase morbidity and mortality in puppies and should be avoided.
- Low doses of medetomidine (2 µg/kg) or dexmedetomidine (1 µg/kg) IV can be used but their effects on uterine blood flow have not been clearly described.

C-SECTION
SURGICAL DESCRIPTION

Cesarean section or C-section is commonly performed in veterinary medicine in cases of dystocia. Although considered a routine operation, it must be carefully planned, with a well-prepared team, to optimize the puppies' or kittens' chances of survival and reduce the risks for the dam.

Preparation for surgery

The time between induction of anesthesia and extraction of the puppies should be as short as possible.

To save time, the surgical site should be shaved, cleaned and, if possible, disinfected before induction of anesthesia. Sufficient staff must be available to assist in the resuscitation of newborns. The surgeon and surgical equipment must be ready before induction.

As soon as the dam is intubated, the surgical site is disinfected once more. After appropriate draping, the incision line is infiltrated with a short-acting local anesthetic *(e.g.,* lidocaine) (see chapter "Anesthesia and analgesia for C-section").

Laparotomy

Following a ventral midline skin incision, the subcutaneous tissue is rapidly dissected, and hemostasis is performed. The abdominal cavity is then opened via the *linea alba*. The length of the surgical wound should be sufficient to exteriorize the uterus.

If possible, the uterus is gently exteriorized from the abdominal cavity and isolated with moist swabs. This step is sometimes difficult or even impossible to perform if a fetus is engaged in the birth canal.

Uterotomy

Holding the uterus between the thumb and forefinger of the non-dominant hand, a scalpel blade incision is made on the body of the uterus on the anti-mesometrial surface or at the base of a uterine horn **(Figure 1).** This incision is then enlarged with Metzenbaum scissors until a fetus can be easily extracted. If this incision is too small, there is a risk of tearing the uterus, which makes suturing more complicated. In case of dystocia, the puppy engaged in the birth canal should be extracted as soon as possible, preferably as a first step.

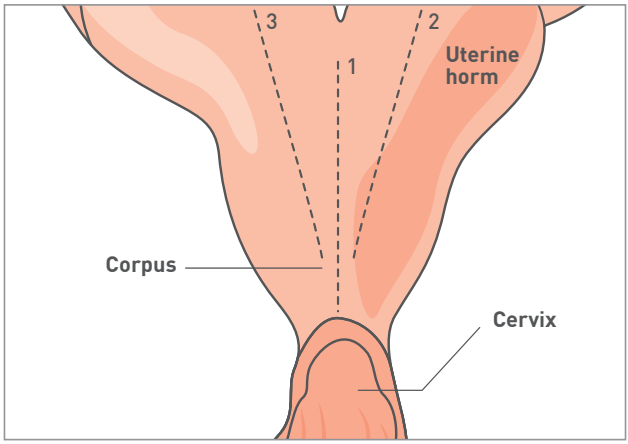


Figure 1. Uterus exteriorization and incision sites (1, 2 or 3).

Fetus extraction from the uterus

The fetus is extracted with or without the placenta and aseptically handed over to a resuscitation assistant **(Figure 2).** If necessary, a hemostat can be placed over the umbilical cord. The umbilical cord is then clamped or ligated by the assistant **(Figure 3).** The placenta is then removed by gentle traction. If it does not come away easily, it is advisable to move on to the next puppy. Other fetuses are guided by external pressure on the uterus towards the incision and extracted in the same way. If the fetuses cannot be moved to the incision, or if the procedure takes too long, another incision can be made if necessary. However, care must be taken to make as few incisions as possible.

Once all puppies have been removed, the uterus is methodically checked for any remaining puppies or lesions, from one ovary to the uterine cervix, then from the birth canal to the second ovary. Once the absence of any other fetus is confirmed, oxytocin is injected at a dose of 0.1 IU/kg (0.167 µg/kg) IV. This allows immediate contraction of the uterus, which reduces bleeding and promotes voiding.

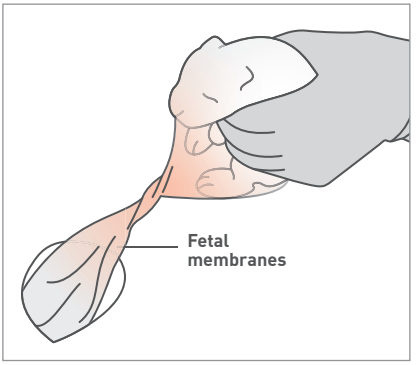


Figure 2. Prehension of the fetus and extraction from the uterus.

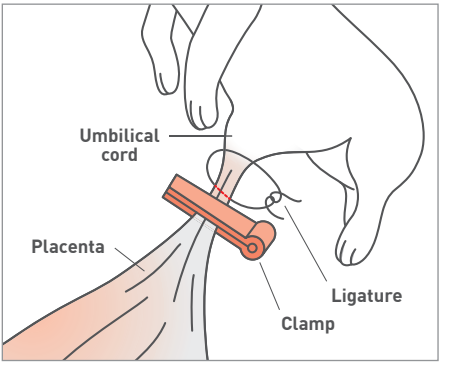


Figure 3. Clamping or ligature of the umbilical cord.

Wound closure

The uterus is closed in two steps, first in a continuous pattern, followed by closure in a Cushing pattern, both with an absorbable monofilament 2-metric suture (3-0 USP) **(Figure 4).** It is not necessary to penetrate the mucosa.

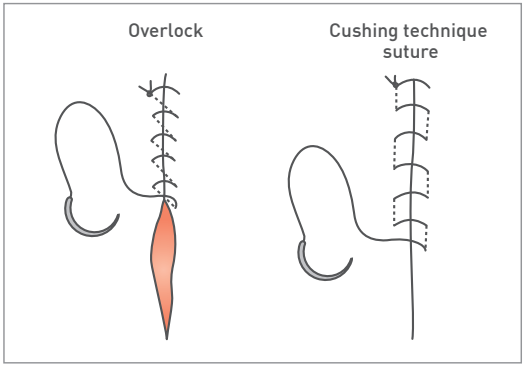


Figure 4. Two-steps sutures of the uterus.

If the abdominal cavity has been contaminated by uterine fluid, especially if the cervix has been open for several hours, rinsing with a saline solution at body temperature (37 °C/98.6 °F) can be performed. The laparotomy wound is then closed in the conventional manner. A continuous intradermal pattern is strongly recommended to avoid wound dehiscence resulting from the activity of puppies or kittens in this area.

Other approach (less common)

An alternative to the conventional C-section is the complete removal of the uterus with the fetuses inside. Of course, this can only be performed if neutering is indicated. After vascular isolation of the uterus with hemostatic forceps, it must be extracted in less than 30 to 60 seconds. The uterus is then handed over to an assistant who rapidly extracts the fetuses. After ligation of the ovarian and uterine vessels, the laparotomy wound is closed as described above. The results obtained are similar to a standard C-section if the extraction of the puppies is carried out quickly.

POSTPARTUM
& LACTATION PERIOD

COLOSTRUM PRODUCTION AND INTAKE IN NORMAL SITUATIONS

Within the first two days of parturition, mammary secretions have a unique composition: their concentration of various classes of immunoglobulins (IgG, IgM, and IgA) are 10-20 times higher than in mature milk. Since feline and canine newborns are nearly agammaglobulinemic, colostrum is crucial for their acquisition of the immunity that will be protective for their first 2 months of life. Canine and feline colostrum are of comparable energy concentrations to milk.

Formation of colostrum

During the final weeks of pregnancy, IgAs (ensuring epithelial immunity) are produced locally within the mammary tissue, and IgGs (systemic immunity) are captured in the mammary tissue from the maternal bloodstream and stored. At the onset of the lactation, the immunoglobulins are released into the mammary alveolar lumen and excreted into the colostrum.

Immune quality of the colostrum

The concentration of Ig is highly variable. It can vary by a factor 20 between bitches and even between mammary pairs of the same dog by a factor of 6. No practical recommendation can be given for preferential suckling from a specific pair of mammary glands to optimize immune transfer. To date, there is no quick test for evaluating immune colostrum quality (a refractometer does not provide interpretable results). But it is rather the quantity of colostrum ingested together with the time of the first suckling that are the main limiting factors of passive immune transfer in domestic carnivores.

In the absence or lack of colostrum, frozen colostrum or commercial substitutes must be administered. Colostrum can easily be collected from a bitch, between 24 to 48 hours after whelping (manual milking is impossible in most queens) into plastic vials, and kept frozen at -20 °C/- 4 °F. A dose of thawed colostrum (thawing performed at 37 °C/98.6 °F, not by microwave) of 1.5 mL/100 g body weight is administered by tube feeding once as early as possible and within the first 8 hours of life in any case.

Colostrum ingestion by the litter

When? Colostrum intake should be encouraged as early as possible (the intestinal absorption rate of Ig drops dramatically within the initial hours after birth). Repeated suckling sessions are to be encouraged as often as possible over the first 8 hours of life; in puppies and kittens, the intestinal barrier closes 12-16 hours after birth, preventing any Ig absorption thereafter **(Figure 1).**

In cats, colostrum intake should not be allowed before checking the blood group of the dam in order to control the risk of isoerythrolysis (see chapter "Neonatal isoerythrolysis in kittens"). Blood groups can be determined at the clinic. In the case of a group B female (in addition to if the blood group of the male used for mating is B for certain), umbilical blood should be collected from each kitten to check their individual blood group: any kitten with group A or AB should not be allowed to suckle during the first 24 (even 36) hours of life, and instead fed a commercial milk; later, they will have to be vaccinated as early as 4 weeks of age (due to the absence of any interference of maternal antibodies in the absence of passive immune transfer).

How much? The quantity of colostrum ingested by puppies and kittens is unknown to date. The quantity of a colostrum of medium quality necessary to achieve the minimum protective blood IgG level is 1.5 mL for each 100 g of newborn body weight (at least in puppies, the quantity is unknown to date in kittens).

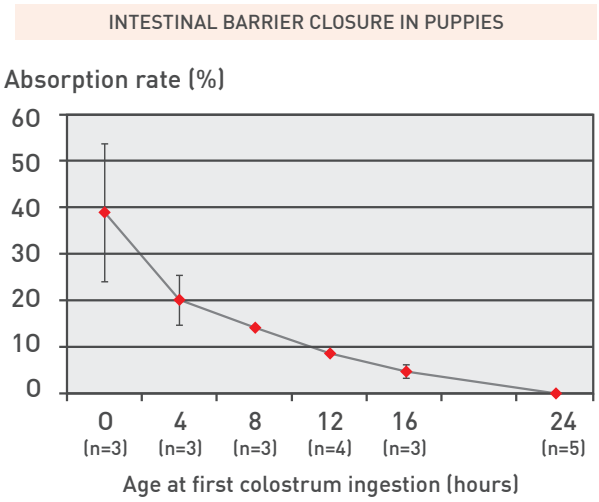
Colostrum ingestion from the maternal side

Maternal behavior is observed as early as the first suckling. If the dam does not pay attention to the litter, does not lie down for suckling or exhibits signs of restlessness (even aggression against the newborns), pain, and stress have to be evaluated and controlled – also check water and food ingestion for adequate colostrum (and later) milk production.

If parturition has been supervised by a veterinarian, regardless of whether delivery took place by vaginal route and/or by C-section:

- The dam and newborns should only be sent home after the first suckling (under supervision, in case of aggressive maternal behavior towards the newborns).
- Lactation can be systemically stimulated through an injection of metoclopramide at the clinic, followed by oral administration at home (0.2 to 0.5 mg/kg q8h for 3 days). Maternal behavior should be observed as the drug has (other) central effects, especially in queens.
- In case of the early death of the whole litter, milk production should be stopped by administration of a dopaminergic drug *(e.g.*, cabergoline) and the mammary glands inspected every day for early detection of any mastitis.

In puppies, passive immune transfer is indirectly evaluated by weighing; a weight at 2 days of age at least equivalent to birth weight is indicative of the ingestion of a sufficient quantity of colostrum and an adequate passive immune transfer.



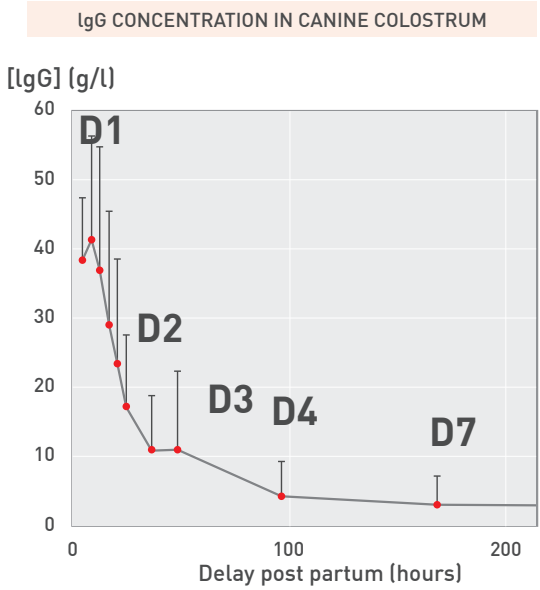


Figure 1. The two main factors influencing passive immune transfer.

From Chastant-Maillard S, *et al.* Timing of the intestinal barrier closure in puppies. *Reprod Domest Anim* 2012, and Albaret A, *et al.* Pattern of immunoglobulin G concentration in canine colostrum and milk during the lactation. *ISCFR* 2016.

SENDING THE MOTHER AND NEWBORNS HOME

Whether following vaginal delivery or Cesarean section (C-section), the dam and litter can only be sent home after several checks at the clinic, with a "to-do list" of specific postpartum advice to optimize neonatal and pediatric survival.

Before discharge

What to check on the mother

- The dam can be allowed home if she is able to stand, has a normal rectal temperature, pink mucosa, and no (or only limited) bloody vaginal discharge.
- In case of a painful delivery and/or C-section, analgesic medication is prescribed for an optimal onset of colostrum/milk production and maternal behavior (tramadol 5 mg/kg PO q12h in the queen, NSAID in the bitch for 5 days).
- An injection of oxytocin [2 IU/kg (3.34 µg/kg) IM or IV, maximum 20 IU (33.4 µg)] will limit uterine bleeding.
- Following a C-section, no bandage is necessary on the abdominal wound; do not fit an Elizabethan collar as this will prevent adequate maternal care of the offspring.

The pet owner must know how to contact the practice or emergency clinic if needed.
In case of doubt, advise the owner to keep a journal or even make a video recording to provide additional information for the veterinarian.

What to check on the offspring

- Check for the absence of any (visible) congenital abnormalities.
- Supervise the first suckling:
  - Newborns are allowed to suckle once fully resuscitated and as early as possible after birth under human supervision (to help newborns to find and latch on to a teat and to avoid adverse maternal behavior).
  - In cats, colostrum intake should only be allowed after checking the blood group of the dam in order to control the risk for isoerythrolysis (risk in case of a group B female if not mated with a B male). See chapter "Neonatal isoerythrolysis in kittens."
  - If colostrum is absent or lacking, frozen colostrum or commercial substitutes must be administered.
- At the clinic, newborns should be maintained in a warm and clean environment, usually away from the mother (to avoid cannibalism). The owner should bring an adapted container for the offspring's transportation *(e.g.,* a kennel with hot water bottles).

Once back home

What to check on the mother

- **Genital tract:** vaginal discharge (appearance, odor); persistent green-colored (in the bitch) or red-colored (queen) discharge is not normal. Pus (white-yellow creamy or foul-smelling purple liquid) is pathologic (indicative of a metritis).
- **General health status:** activity, appetite, rectal temperature, interest in the offspring.
- **Mammary glands:** check for milk production; insufficient milk production will result in crying and restless newborns and a low growth rate; check for the absence of mastitis (redness, pain, inflammation, changes in the milk, local swelling).

- **Maternal behavior:** both disinterest and excessive interest from the dam in the offspring are deleterious for neonatal growth and survival.
- The whelping box should be placed in a quiet area, away from busy routes through the house (for the development of maternal behavior and to control the infection risk), in a clean and easy to disinfect area, heated (first week: 30 °C/85 °F; second week: 28 °C/82 °F; third week: 24 °C/75 °F) at newborn level (for most breeds); to be adapted to toy breeds and cold-adapted breeds, with food and water out of reach.
- Check whether the dam eats, drinks, urinates and defecates. If not, she must be taken out and away from her offspring 3 times per day.

What to check on the offspring

- For individual follow-up, newborns have to be identified *(e.g.,* colored string of wool or Velcro® collars, or adhesive tape folded along its length with a number written at the extremity) **(Figure 1).**

Figure 1. For individual follow-up, newborns have to be identified *(e.g.,* colored string of wool or Velcro® collars).

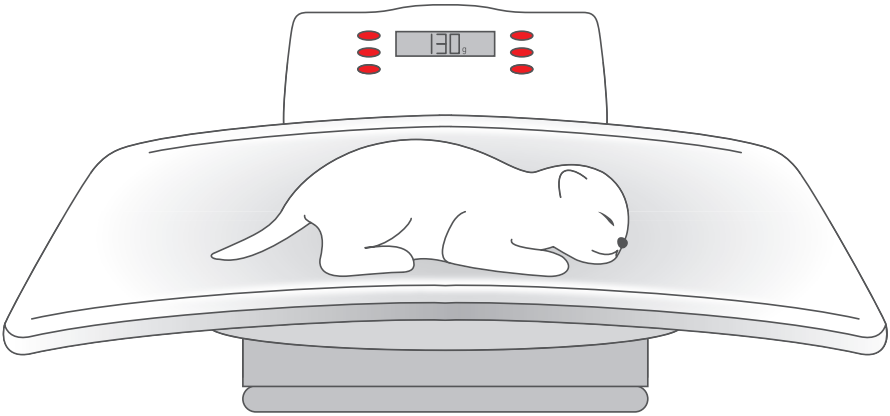


Figure 2. Daily weighing at a consistent time of the day is an easy tool for early disease detection.

- Daily weighing, always on the same scale (accuracy ±1 g; range of weights 50 g to 500 g) **(Figure 2).** Insufficient growth may be associated with insufficient milk production, insufficient milk intake, or the early signs of fading puppy syndrome. Neonatal growth charts are now available to help monitor the early growth of puppies and kittens, from birth up to two months.
- Clinical observation at least twice a day, for the early identification of any signs.
- Umbilical disinfection twice a day with a povidone iodine or chlorhexidine solution *(e.g.,* povidone iodine).
- In case of the death of a puppy, the cadaver is removed and cooled to +4° C/+39.2 °F. The veterinarian is informed in order to schedule a necropsy and appropriate sampling.

NUTRITION DURING THE POSTPARTUM AND LACTATION PERIOD

Lactation is the most energy-demanding period for reproductive animals. Selecting the right diet is critical and it will be the only moment when free feeding will be recommended in order to provide all the nutrients and energy required to sustain production. Colostrum and milk are the only food and water sources of the litter. In situations when natural milk is not available, appropriate milk replacers should be offered.

Composition and function of the colostrum

Passive immunity is crucial at birth as neonates enter a non-sterile environment and their immune system is not fully developed until around 16 weeks of age. Puppies and kittens are also predisposed to hypoglycemia due to low glycogen reserves and high energy demands immediately after birth. Both passive immunity and energy are supplied to neonates via the mother's milk. A specific mammary secretion called colostrum is produced in the first 2 days postpartum and contains immunoglobulins (Ig: IgG, IgA, IgM) necessary for systemic and local immunity. Intake of colostrum Ig is crucial for survival, and inadequate consumption increases the risk of mortality in the initial days of life. Neonatal growth charts are now available to help monitor the early growth of puppies and kittens, from birth up to two months.

Neonates rapidly dehydrate; it is therefore critical for newborns to suckle immediately after whelping to ensure both adequate immune transfer and circulatory volume. Newborn puppies can consume only 10 to 20 mL of milk per feed and kittens are able to handle approximately half to a third of this amount.

Absorption of antibodies by the gastrointestinal tract of neonates is only possible during the first 24 hours of life. Just after birth, 40% of the ingested immunoglobulins is absorbed from the gut lumen to the bloodstream, whereas only 20% is absorbed at 4 hours; from 12 to 16 hours, absorption is less than 10%; and from 24 hours, the intestinal barrier is totally closed in puppies and kittens.

In addition to antibodies, colostrum contains bioactive factors such as lysozymes as well as bile salt-activated lipase to help in the digestion of fats. Colostrum provides energy, with 50% of energy from protein and 40% from lipids (carbohydrates play a minor role). Colostrum also contains high levels of calcium, phosphorus, magnesium, iron, copper, zinc, and vitamin A.

Milk and milk replacers

As lactation progresses, lactose, calcium, and phosphorus levels increase whereas copper, iron, and magnesium concentrations decrease. High concentrations of arginine and taurine are present in the queen's milk, which reflects the unique metabolism of cats *(i.e.,* 4.5 times more taurine in cat milk than in cow milk). Lactose and fat are the primary sources of energy in both cat and dog milk. Intestinal lactase is present early in life in both puppies and kittens and thus they are capable of digesting milk lactose. The nutrient composition of milk is sufficient for normal growth and development until around 4 weeks of age.

If a milk replacer is required, dedicated canine and feline formula are recommended. Feeding a product that differs in composition from natural milk can contribute to anorexia and poor growth. Using cow or goat milk as a milk replacer can result in diarrhea, digestive upsets, and may compromise development. For example, inadequate provision of the amino acids histidine and arginine may lead to cataract development. Bottle feeding or tube feeding 4 to 6 times a day is often required from 2 to 4 weeks of age, and up to 8 to 12 times in the first week of life. Daily weighing is necessary for the first 3 weeks and then every other day or at least twice a week up until full weaning to ensure adequate growth.

Mother's diet

The diet fed to the dam during lactation will impact the quantity and quality of the dam's milk. For example, concentrations of docosahexaenoic acid (DHA) in milk reflect the dam's diet. DHA during perinatal development results in improved visual performance in developing dogs and is essential for neural development. As the energy demands on the lactating bitch and queen are above adult maintenance needs, a general guide is to feed *ad libitum*. Expected needs are 1.5 to 2 times maintenance in the first week, 2 times maintenance in the second week, and 2.5 to 3 times maintenance in the third to fourth week of lactation. Therefore, to avoid weight loss and malnutrition of

It is generally accepted that orphaned puppies need 130 to 150 kcal of metabolizable energy (ME)/kg bodyweight (BW) per day for the first 3 weeks. Daily weight gain averages about 10% of the puppy's current BW during the first 4 weeks after parturition. Newborn kittens require about 24 kcal ME/100 g BW per day for the first 4 weeks of life and should gain 50 to 100 grams per week until 5 to 6 months of age.

the mother and to ensure adequate milk production, a highly digestible, nutrient-dense diet formulated for growth is recommended. Balanced diets should not be supplemented as this may lead to health complications post-whelping such as eclampsia from calcium supplementation. The bitch will lose almost all weight gained in pregnancy after whelping, and the post-whelping weight should be approximately 5 to 10% above her pre-breeding weight. In comparison, only 40% of the weight gained during pregnancy is lost immediately after whelping in the queen, while the other 60% is then gradually lost over lactation. Milk is 78% water, therefore ample water must always be available during lactation. Energy requirements begin to decrease after 4 weeks of lactation when solid foods are introduced to the puppy and kitten.

EVERYDAY CARE OF THE FEMALE

Optimal routine care of the postpartum queen/bitch maximizes normal neonatal health and development. Careful observation of the female in the first three weeks postpartum is essential to ensure she is appropriately caring for the neonates.

- The whelping box should be large enough for the bitch to recline with the puppies and should have puppy rails to minimize a crushing risk, notably in the case of large bitches **(Figure 1).** During the first week, bitches are often reluctant to leave the whelping box and must often be leashed to take routine exercise and elimination breaks outdoors – this should happen every few hours. For the first three weeks it is optimal for the bitch to have no other dog contact to prevent the spread of contagious disease to her neonates. Primigravida, nervous, or post-C-section bitches can have a synthetic pheromone diffusing collar applied.

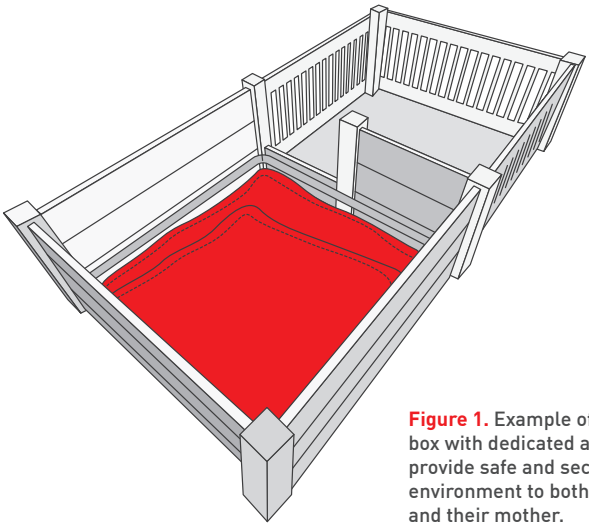


Figure 1. Example of whelping box with dedicated area to provide safe and secure environment to both the litter and their mother.

- The queen should have a clean, personal litter tray close by her queening box, and otherwise be allowed to stay with her kittens in a calm, quiet atmosphere with minimal interruption other than to ensure her health and that of her kittens. Other pets should be kept away from the room enclosing the queen and her neonates.
- Females should have full and free access to a diet appropriate for lactation, and plenty of clean, fresh water. Deworming can continue on a regular basis with products used to minimize or prevent transmission of previously encysted larval forms through the milk, as well as to prevent reinfection from the environment.

Useful, safe products during lactation include fenbendazole and (in dams without the MDR1 mutation) ivermectin.

- Care should be taken that the female's mammary glands are not dragged over an entry door into the whelping or queening box.
- Shaving of the haircoat around the mammary glands is appropriate to prevent hair rings from forming around the nipples. In addition, neonates should have their nails trimmed beginning at about one week of age to prevent skin punctures over the mammary glands by sharp nails. Longhaired bitches and queens may have their tails wrapped for cleanliness during the postpartum period while vulvar discharge is normal and common. Bitches and queens should be routinely monitored for fever, any abnormality of the mammary glands (heat, pain, redness, abnormal swelling), and for any abnormal vulvar discharge (malodorous, purulent).
- Bitches and queens should be exposed to these stimuli beforehand with habituation performed regularly (shaver, thermometer, fabric covering body parts, palpation, etc.).

Ambient temperature in the whelping/queening box should be 24 °C/75 °F, but the dam should not be uncomfortably hot (constant panting, restless). Only safe heating methods (room heat or monitored heat lamps) should be used for additional heat if needed.

MATERNAL BEHAVIOR

Newborn puppies and kittens are highly dependent on external help since they are deaf, blind, and have limited movement. Therefore, good maternal behavior is crucial to their survival.

Maternal behavior is a combination of acts towards the offspring to satisfy their needs. It is not an abrupt change but a subtle adjustment that probably begins during pregnancy due to hormonal modifications. However, the events in the peripartum period, such as normal parturition and a peaceful interaction with the newborn, are key points to optimize maternal behavior. Both parturition and the development of maternal behavior are processes with clear signs **(Table 1)** that can help to monitor the well-being of the dam and consequently of the neonates.

Well before parturition

The genetic background and care of the dam are critical:

- Only well socialized and familiarized animals should reproduce.
- They need to be comfortable with human presence and, better yet, demonstrate an attraction toward humans.
- During the gestation (and lactation) period, stress should be limited – adjust the environment and kennel/house management accordingly.
- Take preventive health measures to limit physiological stress and potential disease.

During parturition

The bitch and queen should have access to appropriate space and nesting materials, with a controlled ambient temperature and environment and limited disturbance. If parturition happens at the clinic (natural or C-section), the female should be accommodated in the most comfortable way with (or at close proximity to) the litter.

It is important to ensure both the needs of the bitch/queen and the litter as this dictates the design/organization of the cage *(e.g.,* temperature). The litter should be kept in a clean and quiet area.

Peripartum and postpartum period

Most maternal interaction decreases over time. Oro-nasal interaction, close-contact time, and nurturing activity change adapting to the needs of the offspring. Although it is difficult to be certain how mothering quality can affect the sociability of puppies and kittens, it is common sense to expect that a peaceful maternity will optimize maternal behavior and most likely improve the cognitive ability of pets.

If the bitch/queen does not display the appropriate maternal behavior (a primiparous female might need more time to adjust to the role of mother) or is too stressed, then she should not be bred again.

It is important to limit pain and stress when humans are present so that the puppies and kittens do not come to associate these behaviors with humans. Moreover, it is important to have regular positive interactions with the dam and her litter, to facilitate the familiarization process with humans.

Table 1. Maternal behavior in dogs and cats around parturition.

Maternal behavior		
	Expected	**Red Flag**
Around parturition	• Building a nesting. Search for a safe place. Looking for close contact and human presence or an isolated place. Bitch: shivering and digging behavior, vomiting, and reduced appetite	• Too unsettled, entering and leaving the nesting area repeatedly. Excessive noise and disproportionate signs of distres or aggressivity
First stage	• Subclinical uterine contractions, beginning of vaginal relaxation, and cervical dilation • Bitch: restlessness, nervousness, panting, nesting, hiding, and anorexia • Queen: repeated visits to the nesting area	• Excessive vocalization and disproportionate signs of anxiety
Second stage	• Strong and coordinated abdominal contractions and active expulsion of the fetus(es) • Queen: interrupted labor – after one or more kittens have been born, the mother will cease straining and rest quietly nursing the kittens • For each newborn – the dam needs to open the amniotic sac and tear the umbilical cord. In addition, it is necessary to lick vigorously to stimulate respiration and dry the newborn	• Presence of green (bitch) or red (queen) discharge without delivering a newborn in 30 minutes • Bitch: more than 4 hours interval after the birth of a puppy in an ongoing labor • Lack of attempt to open the fetal membranes since the newborn will die in a matter of minutes due to asphyxiation • Too rough in tearing the umbilical cord. An inexperienced and/or nervous dam can kill and eat part of or the entire newborn (cannibalism)
Third stage	• Expulsion of the fetal membrane (FM). The dam might eat the placenta	• The FM should be accounted for each newborn. Retained FM can lead to a postpartum metritis
Postpartum period up to three weeks of life	• Keep the offspring warm • Grooming often to stimulate the process of excretion (urination and defecation) • Lick the newborn to guide to the mammary gland and allow them to nurse	• Behavior toward the newborns • Lack of interest and refusing to stay in close contact • Wanting to leave the maternal area often • Any signs of aggression such as growling or trying to bite • Queen: excessive licking • Excessive protection leading to aggression to other animals and humans

ECLAMPSIA

The main postpartum metabolic disorder is eclampsia, also called hypocalcemia or puerperal tetany, which can be associated with hypoglycemia. Eclampsia in female dogs and cats is a life-threatening condition caused by acute hypocalcemia during the peripartum period. Clinical signs are related to a drop in ionized calcium concentration in the extracellular compartment, consequent upon an inability of the mechanisms of calcium homeostasis to compensate for the losses of calcium in the milk.

Eclampsia is more common in female dogs than in cats. It usually occurs during the first 4 weeks postpartum, and much more rarely later in lactation. It may sometimes occur at the end of gestation, especially in toy breeds.

Small breed female dogs with large litters seem predisposed. Other predisposing factors are an unsuitable diet or excessive calcium supplementation during pregnancy. Indeed, eclampsia can also be encountered in large breeds fed with an unbalanced household ration.

Clinical signs and diagnosis

The first clinical signs usually observed are muscle fasciculations, tremors, limb pain, asthenia, facial pruritus, tachycardia or bradycardia, and polypnea. In cats, dehydration, pallor of the mucous membranes, dyspnea, and anorexia are also reported. The female abandons her litter.

Eclampsia is an emergency condition of the peripartum period which most often results in tetany with a preserved state of consciousness. Its treatment is based on the rapid correction of hypocalcemia by intravenous injection of calcium under electrocardiogram monitoring. In the longer term, feeding a modified diet with possibly calcium or vitamin D supplementation is recommended.

The progression is quick, a matter of a few hours. Hyperthermia related to muscle contraction is often present. In cats, hypothermia is sometimes described. Ataxia, tetany, or opisthotonos with retained consciousness occur in severe cases. Seizures are possible. Without treatment, the condition often progresses to death.

The clinical picture of eclampsia is typical. However, this condition should be differentiated from hypoglycemia associated with gestational toxemia. When seizures are observed, the differential diagnosis includes epilepsy, meningoencephalomyelitis, or intoxication.

Further investigation includes the measurement of the plasma ionized calcium concentration (*i.e.*, the free and biologically active form of calcium). In female dogs, clinical signs appear when the blood concentration of ionized calcium drops below 0.8 to 1 mmol/L (3.20 to 4 mg/dL). In cats, the usual values of plasma ionized calcium concentration are between 0.77 and 1.27 mmol/L (3.08 and 5.08 mg/dL). These reference values should be adapted depending on the analyzer.

The value of total blood calcium concentration is not always correlated with that of plasma ionized calcium. Consequently, it should be interpreted according to the bicarbonates, albumin, and anion gap.

Blood glucose testing is necessary because hypoglycemia is a common complication of eclampsia, probably due to increased consumption by the muscles.

An electrocardiogram can be useful: it reveals wide and high T-waves, a prolonged QT interval, and smaller R-waves in affected dogs.

Treatment

Treatment should be initiated as soon as possible, without waiting for the results of blood testing. It is based on the administration of calcium, parenterally and then orally.

The calcium deficit to be corrected cannot be precisely determined. Therefore, the doses of calcium supplementation are adjusted according to the effect obtained. Possible treatment protocols are described in **Table 1.** For parenteral administration, calcium gluconate is preferred to calcium chloride because it causes less tissue necrosis if it is not injected intravenously.

The quantity of elemental calcium should be used when the dose to be injected is calculated. Indeed, 10% calcium gluconate contains 9.3 mg of elemental calcium per mL while 27% calcium chloride contains 27.2 mg of elemental calcium per mL.

To prevent heart disorders, especially arrhythmia, intravenous calcium injections should be administered slowly. The desired amount of calcium can be added to isotonic fluid and given as an infusion. An electrocardiogram is necessary during the infusion to detect any bradycardia or arrhythmia at an early stage. In the event of an anomaly, stopping the infusion and restarting it at a lower flow rate is recommended.

Table 1. Steps and protocols of treatment for eclampsia in female dogs and cats.

Steps and administration routes	Protocols	Comments
Step 1 Emergency Slow IV injection	**Calcium gluconate 10%:** 0.5 to 1.5 mL/kg depending on the clinical effect, for 10-15 minutes	Improvement in 15 minutes
Step 2 (optional) IV Constant rate infusion	**Bitch:** 0.5 to 1.5 mL/kg/h of calcium gluconate diluted in isotonic glucose or NaCl solution **Queen:** 2.5 mL/kg of calcium gluconate 10% every 6-8 hours	*Per os* administration also possible
Step 3 (optional) *Per os* During the rest of the lactation period (at least one month postpartum)	**Bitch:** 25-50 mg/kg/d of elemental calcium divided in 3-4 administrations **Queen:** 50 to 100 mg/kg/d of elemental calcium divided in 3-4 administrations	Avoid recurrence

For oral administration, the presentation generally used is calcium carbonate. This human medicine contains 260 to 600 mg of elemental calcium per tablet depending on the presentation.

In order to prevent a recurrence of eclampsia, it is possible to administer vitamin D or oral calcium, or a combination of both. Vitamin D and its metabolites stimulate the absorption of calcium by the intestines and its reabsorption by the kidneys. It should be administered at a rate of 10,000 to 20,000 IU/day (250 to 500 µg/day). It is preferable to use calcitriol, a metabolite of vitamin D which has a short plasma half-life and a relatively short biological half-life. This allows iatrogenic hypercalcemia to be resolved quickly while it is happening. The recommended dose is 20-30 ng/kg *per os* once a day for 3-4 days then 5-15 ng/kg *per os* once a day for maintenance, adjusted according to the plasma concentration of calcium. A combination of vitamin D and calcium *per os* is possible but in this case, serum calcium concentration must be monitored regularly to avoid hypercalcemia and calcinosis. In parallel, a diet for growing puppies or kittens with a calcium content of approximately 1.4% and a calcium:phosphorus ratio close to 1:1 is suitable.

During persistent convulsions, diazepam or barbiturates can occasionally be used. However, they do not replace calcium supplementation as hypocalcemia is the primary cause of the disorder. In the case of hypoglycemia, glucose correction is also necessary.

Corticosteroids should be avoided because they increase urinary calcium loss, decrease intestinal absorption, and prevent osteoclasis.

During the acute phase of eclampsia, it is recommended to separate the litter from the sick mother for 24 hours. If puppies are older than 3 weeks, it is best to feed them solid food and artificial milk.

In the event of recurrence, a permanent separation is recommended. The drying up of milk production can be achieved using cabergoline (5 µg/kg/day for 5 to 8 days).

Prevention

During the last 2 or 3 weeks of gestation, a diet for growing puppies or kittens, with a calcium content of 1.0 to 1.8%, a phosphorus content of 0.8 to 1.6%, and a calcium:phosphorus ratio of 1:1 to 1.2:1 is recommended. If the diet is of good quality, vitamin or mineral supplements are not recommended.

During lactation, a calcium content of 1.4% and a calcium:phosphorus ratio of 1:1 is desirable.

In females who have experienced eclampsia in a previous pregnancy, oral calcium supplementation is possible during lactation. Calcium carbonate can be used, at a rate of 25 to 100 mg/kg/day divided into three doses. This supplementation is not recommended during pregnancy.

If the litter is large, it is possible to administer milk replacer to the young in addition to maternal milk during the first 3 weeks of life. After this period, solid food can be introduced gradually.

POSTPARTUM GENITAL DISORDERS

Genital disorders occurring after parturition in female dogs and cats should be accurately diagnosed and quickly treated as the consequences for the dam and puppies or kittens are often severe in the postpartum period. Postpartum genital disorders are generally traumatic or infectious. The most common disorder is acute postpartum metritis. Hemorrhage, retained fetuses or placenta, and uterine prolapse may also occur.

Acute postpartum metritis

Acute postpartum metritis is a condition occurring in the immediate postpartum period, generally during the first 3 weeks after parturition **(Figure 1).** Contamination of the uterus generally occurs by opportunistic bacteria from the vagina because the cervix is open during parturition. Metritis may also appear following placental or fetal retention, fetal maceration, prolonged parturition, after obstetric manipulations, or because of poor general hygiene.

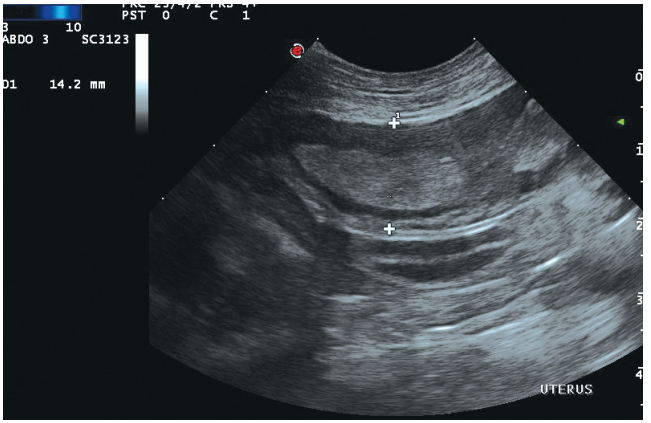


Figure 1. Ultrasound image of postpartum metritis in a bitch.

Clinical signs are purulent and/or hemorrhagic vulvar discharge and a significant impairment of the general health with hyperthermia, anorexia, and vomiting. Signs of sepsis may complete the clinical presentation. Decreased lactation and poor mothering are also reported.

An ascending colonization of opportunistic bacteria from the lower urogenital tract is most often responsible for the condition. *Escherichia coli, Staphylococci, Streptococci, Proteus* spp., *Pseudomonas aeruginosa*, and *Klebsiella* spp. are the most frequently isolated pathogens in female dogs and cats.

A vaginal smear can confirm the presence of bacteria if present in large quantities. Phagocytosis by polynuclear neutrophils corroborates an infection.

An ultrasound exam is performed to assess the uterine wall and contents. Fetal or placental retention may also be observed during this exam.

Aerobic and anaerobic culture with sensitivity testing is performed on uterine pus, sampled from the cranial vagina. Contamination of the sample may be minimized by cleaning and disinfecting the vulva, and by the use of a sterile speculum. Given the nature of the bacterium mainly responsible for this condition *(Escherichia coli)* and the risk of associated bacterial resistance, samples for culture and sensitivity testing should be taken before any antibiotic treatment.

Antibiotic therapy should be started systematically and quickly as soon as the diagnosis is made. The choice of antibiotic is made according to the bacteria in question. The duration of treatment should be adapted to the characteristics of the chosen antibiotic.

Fluid therapy and the correction of electrolyte disorders are provided if the condition of the dam requires hospitalization.

Treatment of acute postpartum metritis consists of antibiotics, supportive therapy with the correction of electrolyte disorders, and uterine voiding.

In breeding dogs in good general condition, uterine voiding can be attempted as an adjunct to antibiotic therapy. Oxytocin in the first 48 hours postpartum and/or low-dose prostaglandins PgF2α promote contractility of the uterus and the elimination of uterine residues which may have precipitated the infection.

In non-reproductive females in good general condition, ovario-hysterectomy may be preferred for this condition in addition to antibiotic therapy.

For animals in shock, it is likely that uterine voiding or emergency surgery is poorly tolerated. In some cases, however, ovariohysterectomy may be seen as a desperate attempt to save life.

Hemorrhage

Hemorrhage is an uncommon postpartum condition. It may result from a physical injury of the genital tract or a coagulopathy. Blood loss is common during parturition, but this is normally limited to the time of delivery. Persistent hemorrhagic discharge is considered abnormal. Pale mucous membranes and/or lethargy should alert the veterinarian or the owner.

Inspection of the vaginal wall is performed by digital palpation. Uterine injury may be diagnosed by ultrasound exam or by endoscopic visualization of blood discharge through the cervix.

Bleeding from a vaginal wall injury may be treated by compression of the wound, clamping or ligature of the affected blood vessels.

Oxytocin [0.1 IU/kg (0.167 µg/kg) q30 min] may help to speed uterine involution and reduce bleeding. Sometimes, laparotomy and suture of the uterine wall or ovariohysterectomy may be necessary.

Retained fetuses and placenta

Retained placenta are uncommon in bitches and queens. The etiology is unknown. Persistent green-colored (in the bitch) or red-colored (queen) vaginal discharge may be observed associated with a restless female. Acute postpartum metritis may follow; therefore, retained material should be expelled as soon as possible. Oxytocin treatment in the first 48h is indicated. After 48h, small doses of prostaglandins PGF2α may be helpful if material is still retained.

In the case of retained fetus, C-section or ovariohysterectomy may be indicated if medical treatment is unsuccessful or contraindicated.

Uterine prolapse

Complete or partial uterine prolapse is rare in female dogs and cats **(Figure 2).** The diagnosis is based on recent parturition, and the presence of a firm, tubular mass protruding from the vulva. Vaginal hyperplasia, which may happen around the time of parturition because of estrogenic impregnation, should be ruled out. Because of the size of bitches and queens, manual replacement is rarely possible and laparotomy with ovariohysterectomy is generally indicated.

Figure 2. Uterine prolapse in a queen.

POSTPARTUM MAMMARY DISORDERS

Colostrum and milk are the only food and water sources of the litter. It is critical for their survival and subsequent healthy development to ingest the right amount and a high quality mammary secretion. Nevertheless, conditions, whether nutritional, metabolic, psychological, or pain-related, can impact milk production and put the entire litter at risk. In addition, we can also have non septic congestion of the mammary gland or even mastitis. In this latter situation with the most severe cases, not only the litter is at risk but the female as well.

Agalactia/hypogalactia

Primary agalactia is a failure to produce any milk or colostrum to feed the newborn. It is very rare in domestic carnivores.

Secondary agalactia or hypogalactia is low milk production or a defect in milk let-down.

Those different conditions are usually suspected when the newborn fails to gain weight in their first days of life.

Causes of agalactia or hypogalactia

- Malnutrition or poor appetite resulting in a failure to consume the daily nutritional needs (including water intake).
- Systemic illness.
- Premature parturition (mammary gland unprepared for milk demand).
- Infectious conditions: mastitis, metritis, or endotoxemia.
- Any painful condition, for example after a cesarean delivery.
- Stress and anxiety of the dam can block milk production and let-down.
- Milk demand higher than milk production: occurs in large litters.

Treatment of agalactia or hypogalactia

- Rehydrate the dam and ensure balanced nutrition for milk production.
- Metoclopramide: 0.3 mg/kg PO q8h until milk production improves (possible extrapyramidal effect seen as restlessness or ataxia).
- Domperidone 2.2 mg/kg PO q8 to 12h and up to 2 days beyond desired milk production (possible diarrhea).
- If anxiety is observed in the dam, drugs such as acepromazine or pheromone analogs like Adaptil© (CEVA Animal Health) can be used.
- Oxytocin to help milk let-down: 0.25-1 IU/dam (0.41-1.67 µg/dam) q 2 to 4h for 1 to 2 days.
- Hand feed the newborn if no colostrum is available (see chapter "Colostrum intake in pathologic situations").

Mammary congestion/galactostasis

This occurs if milk production exceeds demand (small litter, loss of litter, or after weaning). Unlike mastitis, this condition is not septic, and no general illness is observed. The mammary gland will be enlarged and might be moderately painful but should not be red.

Treatment for nursing dams

- Apply cool compresses to engorged glands and alternate with warm compresses to soften gently.
- Massage the glands frequently and stimulate milk let-down.
- Ensure that neonates suckle well and regularly.

Treatment for dams with no neonate

- Cabergoline (dopamine agonist) 5 µg/kg/day PO up to 10 days if necessary.
- Apply cool compresses to the glands for 10 min every 8h.
- NSAIDs if necessary.
- No other manipulation of the gland.
- Food intake can be reduced for 24h.

Mastitis

Mastitis is an infection that can affect one or several glands **(Figure 1).** The infection can be ascending or descending (lymphatic or hematogenous, secondary to puerperal genital or digestive infections, such as metritis and periodontitis; those conditions should be investigated). However, the main route seems to be ascending through the teat canals or cutaneous lesions that puppies/kittens will produce by intensive suckling. *Staphylococcus aureus* and *Escherichia coli* are the main pathogenic agents found.

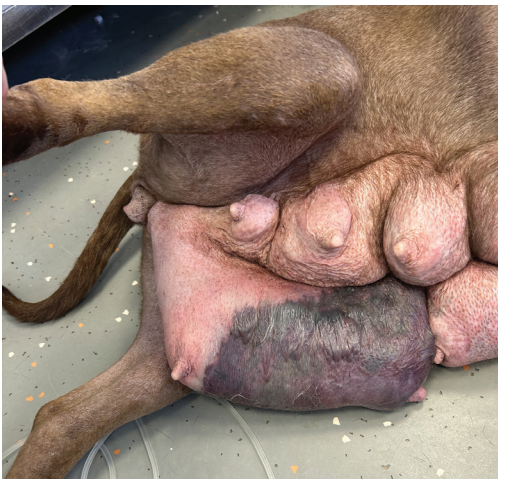


Figure 1. Example of a gangrenous mastitis.

Mild mastitis (dam in good general condition, apyretic)

- Let the neonates nurse (except if the gland is abscessed).
- Gently massage the gland with warm compresses.
- Antibiotics if needed: in an acute situation, betalactamines will easily cross the milk-plasma barrier.

Moderate to severe mastitis

- Fluid therapy.
- Antibiotics for at least 8 to 10 days at the highest permissible dose and frequency, antibiotic of choice depending on milk pH:
  - > 7.4: penicillins, cephalosporins.
  - < 7.4 and Gram + bacteria: macrolides.
  - < 7.4 and Gram – bacteria: trimethoprim/sulphonamide, quinolones (remove the neonates).
- Analgesia: opioids +/- NSAIDs (remove the neonates).
- Gangrenous mastitis: support the dam until the necrosis stops and then surgically debride.

NEONATAL PERIOD

NEONATAL RESUSCITATION

Appropriate neonatal resuscitation is crucial for early neonatal survival. It is mandatory in C-sections, but also in some cases of vaginal delivery (in case of absent or abnormal maternal care; and in any case where no respiratory movements appear within a minute of birth).

Context

- The procedure is conducted (to the extent possible) on a heated pad or mattress (32 °C/89.6 °F), with clean and gloved hands.
- All the materials used are to be disinfected or sterile.
- The procedure must be conducted by trained staff.
- The table dedicated to resuscitation should be large enough to allow all the staff to stand and take care of the whole litter.
- The umbilical cord and connection to its placenta should be preserved for as long as possible.
- If a serious congenital malformation is found (such as anasarca = water puppy/kitten or schistosoma reflexus), resuscitation can be skipped and the newborn euthanized by an injection in the umbilical vein (or intracardiac).

Neonatal resuscitation procedure

The procedure can be described by the acronym ABC (Airways, Breathing, Circulation), aiming to help the newborn adapt to extra-uterine life.

1. Free the airways

- Remove the amniotic membranes (both in C-section and after vaginal delivery if the dam does not remove the membranes herself).

- Free the airways from amniotic fluid: with the head of the newborn down and the neck in semi-extension, aspirate fluids from the buccal cavity (and secondarily, from the nasal cavities, but due to the narrow nostrils, the quantity of aspirated liquid is limited) with a baby nasal aspirator or a bulb.
- Swinging newborns is strongly discouraged (risk of shaken newborn syndrome, cerebral hemorrhage).

2. Induce breathing

- By vigorous friction-compression of the thorax, from the costal arch in direction of the neck, with a dry towel. The head is kept down to help drain amniotic fluid from the respiratory tract.
- If no breathing movement appears after 5 minutes of friction:
  - Stimulate the acupuncture point GV26 **(Figure 1):** a 27-gauge or acupuncture needle is inserted into the nasal philtrum, at the base of the nares; when the cartilage/bone is reached, the needle is rotated.
  - Pain can be induced by pinching the dorsal line of the newborn or a limb extremity.
- Drugs have limited efficacy in initiating breathing:
  - Doxapram administration is generally not recommended; if used, one drop should be administered sublingually once, providing an oxygen supply is available.
  - If opioids were injected to the dam during C-section before fetal extraction, 1-2 drops of naloxone (0.002-0.02 mg/kg) are administered sublingually.

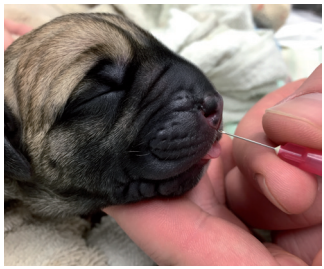


Figure 1. The JenChung GV26 acupuncture point used to stimulate respiration; a 27-gauge or acupuncture needle is inserted into the nasal philtrum until it contacts bone and then twisted.

3. Once respiration is induced, cardiac function is evaluated

- If mucosa doesn't turn pink, oxygen is delivered to the newborn through a pediatric mask on an open circuit (the whole head or even the body to the mid-thorax is placed in the mask).
- Bradycardia is a normal protection mechanism in the newborn. It is thus contra-indicated to inject drugs to increase cardiac frequency in the absence of respiration. If bradycardia persists after the onset of breathing:
  - Perform direct transthoracic cardiac compression 1-2 beats per second, by compressing the chest between thumb and forefinger.
  - If ineffective after 2 minutes, epinephrine can be injected (100 µg/kg diluted into 0.5 mL of crystalloid) via the umbilical vein (thin-walled vessel from the umbilical cord), or intraosseous or intravenous route (usually ineffective). Atropine is not recommended.

Others

Hypoglycemia [< 2.2 mmol/L (40 mg/dL)] also contributes to resuscitation difficulties. It can be corrected by an intravenous (or intraosseous) injection of a bolus 2-4 mL/kg body weight of a 10% dextrose solution. Honey can be applied on the buccal mucosa, providing circulation is effective.

Evaluation of the efficiency of resuscitation

Resuscitation can be stopped after 20 minutes of active efforts.

The so-called APGAR score, adapted from human medicine, is a simple tool for the evaluation of the vitality of newborns **(Table 1).** Five parameters are scored individually (on 2 points) and then 5 scores are totaled. Resuscitation is considered sufficient if the APGAR score is ⩾ 7/10.

Table 1. APGAR score calculation.

Parameter	APGAR score			
	0	1	2	
A: Appearance Mucosa color	Cyanotic	Pale	Pink	/2
P: Pulse Heart rate	< 180 bpm	180-220 bpm	> 220 bpm	/2
G: Grimace Irritability reflex	Absent	Grimace	Vigorous	/2
A: Activity Motility tone	Flaccid	Some flexions	Active motion	/2
R: Respiration Vocalization/ respiration rate	No crying < 6 rpm	Mild crying 6-15 rpm	Crying > 15 rpm	/2
				Total /10

bpm – beat per minute, rpm – respiration per minute

Once resuscitation is achieved

- Check for congenital abnormalities *(e.g.,* hydrocephalus, cleft palate/lip, limb abnormality, imperforate anus, pectus excavatum) and make an immediate decision on euthanasia following discussion with the owner.
- Umbilical cord care: newborns are separated from their placenta; the umbilical cord is compressed between two fingers and the umbilical content is pushed into the newborn; the cord is gently elongated, and a ligature is placed ≈ 2 cm from the abdomen with a surgical suture and then the umbilical cord is sectioned below the ligature. Disinfection is performed by dipping the cord into 2% iodine tincture.
- All newborns should be identified *(e.g.,* colored ribbons, soft Velcro® collars) and weighed.
- They are placed in an incubator (30 °C/86 °F, 60% humidity) with an atmosphere enriched with oxygen until the first suckling can be achieved as soon as possible after birth (only once resuscitation is complete).
- Once the dam leaves the operating room, the mammary glands should be cleaned and the neonates attached to the teats. Colostrum ingestion is organized as soon as possible (within the first 8 hours of life in any case) under permanent supervision (to prevent the dam from hurting newborns).
- Abdominal and perineal massage of the puppies with a warm, wet tissue to stimulate urination and defecation can be done beforehand to obtain meconium expulsion but it is crucial after the first feeding since at this stage the neonates are unable to initiate excretion by themselves.
- After a C-section, the interaction with the offspring needs to be under surveillance until normal maternal behavior is observed. Wetting the neonates with amniotic fluid possibly improves maternal bonding.

NEONATAL ISOERYTHROLYSIS IN KITTENS

Feline neonatal isoerythrolysis (FNI) is a rare immune-mediated disease that arises if newborn kittens with blood type A consume colostrum from a mother with blood type B. The antibodies contained in the colostrum are absorbed, bind to the kitten's erythrocytes, and destroy these blood cells provoking hemolysis.

Predisposition

Blood type A is dominant over blood type B. Therefore, type A cats can be either homozygous (genotype *AA)* or heterozygous *(Ab).* Approximately 95% of type B *(bb)* queens have strong isoantibodies against blood type A. Mating a type B female with a type A male will produce 100% of kittens at risk, while mating a B female with an AB male will produce 50% of kittens at risk. At-risk kittens (group A or AB) can develop immune mediated hemolysis, disseminated intravascular coagulation, acute renal failure, and death. The feline placenta only allows a limited passage of maternal antibodies, which are mainly transferred via the colostrum. FNI affects type A or AB kittens born from a blood type B mother by getting anti-A antibodies when they start suckling.

Clinical signs and diagnosis

Breeds with a high prevalence of type B include the Turkish Van and Angora (45-60%), British shorthair, Cornish, and Devon Rex (30-40%), and the Scottish Fold, Birman, Somali, Abyssinian, and Ragdoll (14-20%).

The kitten is born healthy and nursing vigorously. Signs, such as hemoglobinuria, anemia, jaundice, and depression appear within a few hours or days after colostrum ingestion. Key signs are dark red-brown urine, indicating severe intravascular hemolysis and hemoglobinuria. The kittens stop nursing and weaken ("fading kitten syndrome"). In the mild form, necrosis of the extremities (tail, ears) might be observed. In the most severe form, death can happen quickly **(Figure 1).**

Diagnosis is based on clinical signs and is confirmed by blood typing the kitten and queen. If blood typing is not possible, crossmatching can be performed **(Figure 2).**

- Major crossmatching: the mother's plasma is mixed with the kitten's RBC solution.
- Minor crossmatching: the kitten's plasma is mixed with the mother's RBC solution.

After incubation and centrifugation, the mixtures are checked: any hemolysis or the presence of agglutination indicates incompatibility.

Figure 1. Isoerythrolysis occurs when the mother has antibodies against the blood type of the newborn.

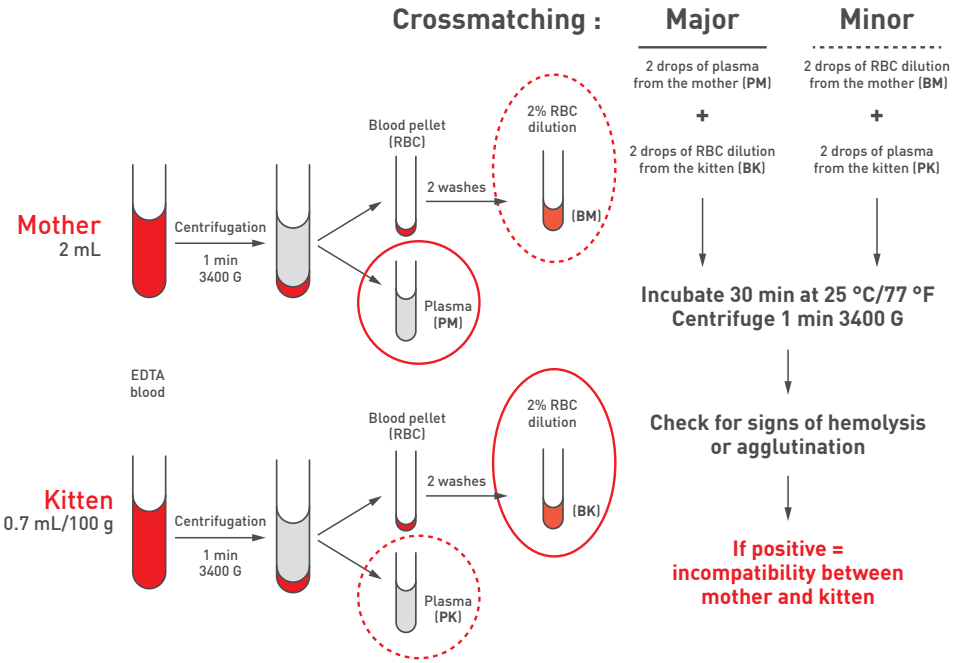


Figure 2. Crossmatching can be performed if blood typing is not possible.

From Silvestre-Ferreira A, *et al.* Feline Neonatal Isoerythrolysis and the Importance of Feline Blood Types. *Vet. Med. Int.* 2010.

Treatment

Kittens should be removed from their mother immediately as they will continue to ingest anti-A immunoglobulins as long as they suckle. However, this is only necessary for the first 24 hours of life, as the kittens' intestinal mucosa loses its permeability after around 16 hours. Kittens may be fed a commercial milk replacer, previously frozen milk from a type A blood queen, or be placed with a foster type A blood queen.

If anemia is severe and becomes worse, blood transfusion should be considered. Severely anemic kittens should receive 2 to 3 mL of previously washed blood cells during the first 3 days of life.

Blood can be transfused via a spinal needle in the trochanteric fossa of the kitten. In this way 90% of red blood cells will be in the circulation in 10 minutes.

Before 3 days of life, the queen [type B] is the best donor. If another blood transfusion is required after 3 days, washed type-A blood should be considered.

Prevention

As treatment is rarely successful, it is much more important to prevent this problem from occurring.

Prevention regarding parents: blood group typing is essential in at-risk breeds prior to mating and the tom and queen should be appropriately matched, *e.g.,* mate a *bb* female with a *bb* male or use an *AA* female who will have very few isoantibodies against type B even if bred with a *bb* male.

Prevention regarding kittens: at-risk kittens should not be permitted to suckle their mother for at least the first 24 hours after birth. A blood type A queen in lactation can replace the nursing mother. A milk replacer can be used as a source

of energy, but there are no specific antibodies to ensure the kitten's immunity. In that situation, it would be ideal to use frozen colostrum from a blood type A queen which can be kept for up to 12 months in the freezer.

Another solution is to administer serum or plasma from a blood type A cat orally or subcutaneously. In that case, large volumes are needed to provide the appropriate quantity of IgG, because the concentration of IgG is 5 times lower in feline serum than in colostrum. At the same time, milk replacer must be provided to meet energy demands. The kittens can start suckling their mother after 24 hours because their intestinal permeability and IgG absorption is negligible after 16h of life. It is important to keep kittens together with their mother who should wear a "medical pet-shirt" protecting the mammary gland, and to remove the colostrum by milking during the first day after parturition to stimulate lactation.

It may be necessary to start a vaccination protocol as soon as the 4th week of age as those kittens will not have received passive immune transfer.

TUBE FEEDING GUIDELINES

Neonates that are premature, weak, have problematic congenital defects (cleft palate, nose, lips), are orphaned, or have mothers that are agalactic, ill, or deceased require hand feeding. For many of these neonates, tube feeding is the safest and most effective way to ensure correct nutrition if done properly.

Prior to feeding, ensure the neonate's body temperature is at least 35.5 °C/96 °F as hypothermic neonates cannot digest formula.

The tube used is a red rubber catheter, from French gauge 5 to 14, depending on size and species of neonate. Ideally, use the largest tube that readily passes into the neonate to minimize or eliminate the possibility of the tube tip recoiling and reentering the esophagus or airways. Measure the tube length, with the neonate on its side with the neck in natural flexion, from the tip of the nose to the last rib. Mark this length on the tube (note that as the neonate grows, remeasurement at regular intervals is necessary). To pass the feeding tube, place the neonate in an upright position, insert the tip of the tube in the neonate's mouth, on the midline of the dorsal surface of the tongue, and pass it slowly into the esophagus (the neonate will swallow the tube). Passing the tube nearly to the mark will ensure the tube is within the stomach **(Figure 1).** Once the tube is in place, gently squeeze a toe or tail tip to ensure placement is not in an airway: vocalization is not possible if it is. Ultrasound can be used in hospital settings to ensure gastric placement of the tube. Esophageal placement is not desirable as it increases the risk of aspiration.

High quality commercial formula for the species is important, although homemade recipes can be used, but ONLY in an emergency. Powdered formulas should be diluted as needed and warmed to 35-38 °C/95-100 °F for feeding. Once the feeding tube has been properly placed, the syringe containing the measured formula is attached and the syringe is slowly depressed and formula deposited in the stomach. Amounts for full supplementation are noted in the chart **(Tables 1 and 2).** On the first day, gastric size is 1.9 mL in neonatal puppies and 1.2 mL in neonatal kittens. After that time, its volume is estimated at about 40 mL/kg of body weight. Monitor gastric distention and do not overfill the stomach. The tube should be kinked prior to removing it from the neonate to prevent spillage from the tube and possible leakage into airways.

In premature, stressed, and ill neonates, and quite commonly in kittens, gradually build up to full feeding and to full strength formula. Diluting the formula and feeding a little less for a few days can be done to prevent adverse gastrointestinal events in these neonates. The amount should be adjusted to attain the desired normal daily weight gain. If there is concern about use of the formula, aspiration of the stomach prior to tube feeding can be performed to ensure formula is being digested and it is safe to feed again. All neonates that are tube/bottle fed should be stimulated to urinate and defecate with a warm and wet cloth after feeding.

Table 1. Puppy feeding chart (adjust to gain 5-10% of birth weight daily).

Week 1	13 mL/100 g divided into 8 meals/day
Week 2	16 mL/100 g divided into 5 meals/day
Week 3	20 mL/100 g divided into 4meals/day
Week 4	22 mL/100 g divided into 4meals/day
	Start puppy mush four times daily at 3-4 weeks of age.

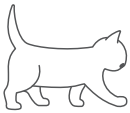


Table 2. Kitten feeding chart (adjust to gain 10-15 g/day).

Birth	5 mL/100 g divided into 8 meals/day
Week 1	Increase by 1-2 mL/100 g divided into 8 meals/day
Week 2	20 mL/100 g divided into 5 meals/day
Week 3	25 mL/100 g divided into 4meals/day
Week 4	30 mL/100 g divided into 4meals/day
	Solid food (mush and dry) started at 4-5 weeks. If a milk replacer is used, follow the manufacturer's instructions.

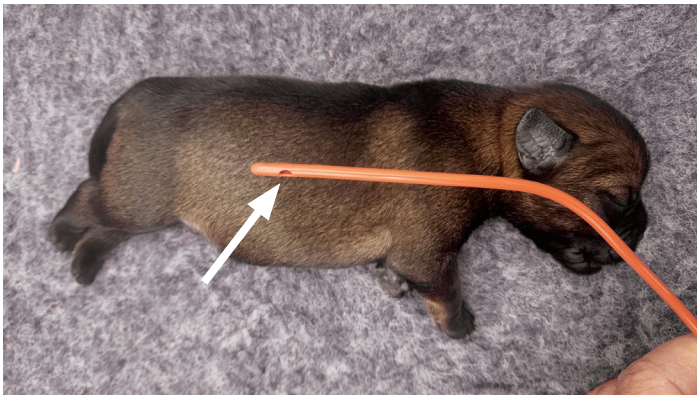


Figure 1. Measuring the feeding tube length on a Border Terrier puppy.

COLOSTRUM INTAKE IN PATHOLOGIC SITUATIONS

Several postpartum disorders may hinder colostrum intake in newborns. Some of them are of maternal origin (agalactia, inappropriate maternal behavior, death of the mother) whereas others have neonatal causes (hypoxia, weakness, hypothermia, neonatal isoerythrolysis, low birth weight).

Whatever the cause of failure of the colostrum intake, an assistance for suckling or a colostrum replacer should be offered to the newborn. An assisted suckling is desirable to ensure an optimal energy and immune intake in vigorous puppies and kittens with a correct suckling reflex. Otherwise, and in case of some issues of maternal origin (no milk, infection, aggression) frozen colostrum or colostrum replacers should be administrated to increase the chances for newborn survival.

Assisted suckling

Once neonatal resuscitation has been performed, newborns should immediately have the chance to suckle. The dam should lay down and puppies or kittens should be placed in front of a teat. If they do not latch on to the teat by themselves, then they should be helped by putting a teat into the mouth. A suckling session should last about 15 minutes and should be repeated every 1-2 hours during the first 24h to stimulate lactogenesis.

Freezing colostrum

This section mainly concerns dogs as colostrum banking in the queen is challenging in practice.

Freezing:

1. Choose a healthy donor female at about 24h after the beginning of parturition, with vaccinations up to date, ideally from the same kennel as the receivers.
2. Clean your hands and put gloves on.

3. Inject 1-2 IU/1.67-3.34 µg of oxytocin IM to stimulate milk let-down.
4. Clean the mammary glands with a chlorhexidine disinfectant and rinse them with warm water.
5. Collect the colostrum ideally into sterile plastic or glass tubes of about 5-10 mL by gently massaging the entire mammary tissue **(Figure 1).**
6. Freeze and keep colostrum at -20 °C/-4 °F until thawing (a maximum 1 year after freezing).

Thawing:

1. Calculate the dose of the colostrum necessary for the entire litter. It is recommended to administer 1.5 mL/100 g of body weight in a single dose.
2. Put the tube(s) containing the colostrum into a water bath at 35 °C/95 °F until thawed. Check the temperature, which should not exceed 37 °C/98.6 °F (denaturation of immunoglobulins at a high temperature). Avoid microwaves.
3. Administer the thawed colostrum to the newborns within the first 4-8h of life via a feeding tube.

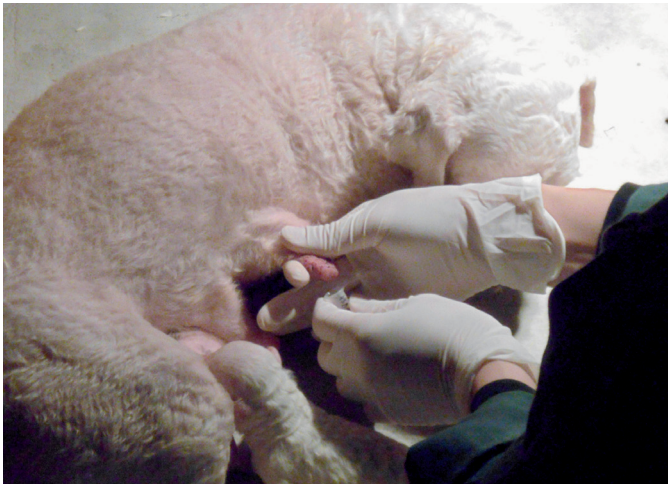


Figure 1.
After cleaning the mammary gland, collect the colostrum by gently massaging the entire mammary tissue.

Colostrum replacers

Several solutions exist to replace maternal colostrum. Although none of them have all the advantages of the maternal colostrum, some of them are more beneficial for the newborn then the others **(Table 1).** In order to control the ingested volume, colostrum replacer should be provided via a feeding tube within the first 4-8h after birth.

Table 1. Colostrum replacers.

Type of replacer*	Advantages	Disadvantages
Canine/feline serum or plasma	• Provide specific canine or feline immunoglobulins • Have scientifically proven beneficial effects in puppies and kittens	• Provide almost no energy • Require a blood donor
Colostrum from cattle or goats	• Easily available • Provide some non-specific immunological components	• May provoke diarrhea due to a higher osmolarity • Contains less than half the energy than maternal colostrum • No demonstrated beneficial effects on the health of newborns
Canine milk replacer enriched with hyperimmune egg powder (Puppy PROTECH)	• Provides specific antibodies against E. coli and canine parvovirus • Provides an adequate amount of energy • Has scientifically proven beneficial effects in puppies	• Not available in some countries • Contains no other immunologically active compounds

** Milk replacers enriched with specific antibodies targeted against canine/feline pathogens seem to be the most beneficial for newborns.*

HOW TO DEAL WITH LOW-BIRTH-WEIGHT PUPPIES AND KITTENS?

The cause of low or very low birth weight in puppies and kittens is still unknown, although some alimentary, genetic, and epigenetic causes may play an important role in its development.

What is low birth weight?

The definition of low birth weight is based on the weight at birth. The thresholds of low birth weight (LBW) and very low birth weight (VLBW) depend on the species, breed, or even genetic lineage **(Tables 1 and 2).** Respectively, these two thresholds distinguish newborns at slightly higher and those at very high risk of death compared to normal birth weights (NBW) puppies. Puppies with a NBW have a neonatal mortality of 4% (during the first 21 days of life), for LBW puppies this is 9% and for VLBW as much as 55%. This vulnerability is linked to their low energy reserves, higher body surface/mass ratio, and low vitality compared to normal weight littermates, predisposing them to hypothermia and hypoglycemia.

In case of retarded growth, weight monitoring should be maintained on a daily basis.

Table 1. Classification of newborns according to their birth weight.

Breed	Normal birth weight (g)	Low birth weight (g)*	Very low birth weight (g)**
Australian Shepherd	> 375	213-375	< 213
Bichon Frise	> 181	163-181	< 163
Cocker Spaniel	> 280	142-280	< 142
German Shepherd	> 480	338-480	< 338
Golden Retriever	> 417	177-417	< 177
Labrador Retriever	> 406	248-406	< 248
Maltese	> 163	115-163	< 115
Rottweiler	> 410	345-410	< 345
Shih Tzu	> 176	128-176	< 128
West Highland White Terrier	> 190	129-190	< 129

** According to ROC curve analysis. ** According to CART analysis.*
From Mugnier A, *et al.* Low and very low birth weight in puppies: definitions, risk factors and survival in a large-scale population. *BMC Vet Res* 2020.

Table 2. Classification of newborns according to their birth weight.

Breed	Normal birth weight (g)	Low birth weight (g)*	Very low birth weight (g)*
Abyssinian / Somali	> 94	60-94	< 60**
Balinese / Mandarin / Oriental / Siamese	> 82**	78-82	< 78
Bengal	> 84	60-84	< 60**
Birman	> 74	60-74	< 60**
Bristish	> 87	61-87	< 61
Chartreux	> 100	60-100	< 60**
Egyptian Mau	> 104	61-104	< 61
Maine Coon	> 81	75-81	< 75
Norwegian Forest	> 94	60-94	< 60**
Persian / Exotic	> 82	60-82	< 60**
Ragdoll	> 84	60-84	< 60**
Russian Blue / Nebelung	> 86	60-86	< 60**
Scottish / Highland	> 77	60-77	< 60**
Siberian	> 90	63-90	< 63
Sphynx	> 76	60-76	< 60**

** According to CART analysis. ** Threshold established at the species level.*
From Mugnier A, *et al.* Association between Birth Weight and Mortality over the Two First Months after Birth in Feline Species. *Animals* 2023.

How to manage low birth weights?

As the risk of death in low-birth-weight newborns is high, they should be provided with special care to increase their chances of survival:

- To identify LBW and VLBW, all newborns should be weighed at birth (at home or at the veterinary clinic in case of dystocia or C-section) using an appropriate scale: with an accuracy of ±1 g; range of weights 50 g to 500 g **(Figure 1).**
- All newborns should be assisted to suckle regularly during at least the first 8h after birth *(i.e.,* before the intestinal barrier closure) to ensure passive immunity transfer. Puppies and kittens should not leave the veterinary clinic before the first suckling has been observed.
- It is strongly recommended to start the artificial feeding of VLBW puppies with milk formula from the first day of life to provide them with extra energy. Partial supplementation may be carried out on the first day in parallel with maternal colostrum intake and adapted the next day depending on the clinical status of the newborn.
- Body temperature should be monitored in VLBW puppies several times daily (before each meal) during the initial days after birth, especially if administering milk formula. If the temperature is < 34 °C/93.2 °F, the newborn should be warmed prior to feeding.
- Glycemia is measured using a portable glucometer with blood from a marginal ear vein puncture. This may be required at least daily in VLBW puppies and kittens. Newborns with blood glucose values < 2.22 mmol/L (40 mg/dL) should be considered hypoglycemic. In the case of hypoglycemia and hypothermia, a source of energy other than milk formula should be considered, such as dextrose or glucose provided immediately and ideally via the intravenous route.
- Weight monitoring is mandatory at least once per day until 3 weeks of age, and then every other day or at least once per week until adoption **(Figure 2).**

Figure 1. Even if smaller individuals can be visually identified within a litter, it is of crucial importance to monitor the weight of all the siblings daily from birth up to at least 3 weeks of age.

Figure 2. Neonatal growth charts are now available to help monitor the early growth of puppies and kittens, from birth up to two months.

NURSING OF ORPHANED PUPPIES OR KITTENS

Hand rearing puppies and/or kittens may be necessary if the dam is unable to provide care for the offspring, to replace maternal care for all physiological needs (temperature, nutrition, hydration, and stimulation to excrete), and later on for socialization. The challenge is to provide the right care and identify any problem as soon as possible to avoid neonatal mortality.

What is nursing and when is it needed?

In bitches and queens, lactation may begin a few days before parturition or at most just before expulsion. On the first day postpartum, the volume of milk (colostrum) produced is low, but it increases gradually, with the final mature milk yield adapted to the number of newborns within a litter. However, in some cases, the onset of lactation is retarded or it does not appear at all *(e.g.,* stress, C-section, disease); in other cases, the volume of milk produced is low *(e.g.,* very large litter). Finally, in some cases, newborns may be separated from the mother (aggressive behavior towards newborns or death of the mother). Nursing consists of artificial feeding, providing a heat source in the nest, ensuring basic care, and health monitoring, all mandatory in orphaned puppies and kittens for their survival.

How to choose a milk replacer?

The milk composition evolves during lactation, with the colostrum being secreted during the first 24h after parturition onset, followed by the transition milk until 48h later, and changing to the mature milk from day three of lactation. Not only the level of immunoglobulins changes during lactation, but also that of macronutrients and the total energy content, from colostrum rich in IgG and energy to milk rich in IgA and lactose. Milk replacers should be as similar as possible in composition to maternal milk. This is why, ideally, colostrum replacers should be administered to newborns during the first few days of life (until 2 days), and the milk replacer only afterward.

Colostrum replacer

In the absence of maternal colostrum, canine or feline frozen colostrum should ideally be used as a replacer. Another solution, containing several immunologically active compounds, consists of the administration of canine or feline serum or plasma in addition to a milk replacer. Finally, some commercial milk replacers contain hyperimmune egg powder, providing the newborn with some specific antibodies, in addition to energy, micro and macronutrients, vitamins, and other supplements *(e.g.,* DHA). They are a good alternative in the absence of frozen colostrum.

Milk replacer

Many milk replacers are available on the market with a large variability in their composition. For instance, a 3-fold difference in gross energy content exists between different milk replacers. Care must be taken to provide the newborn with a sufficient quantity of energy; the energy content in maternal dog and cat milk is about 1300-1800 kcal/L.

When choosing a milk replacer, any product containing starch should be excluded, as the secretion of amylase by both the pancreas and intestinal villi is very limited in puppies and kittens before 4 weeks of age. The administration of such a milk replacer may lead to diarrhea. Bovine and caprine milk are to be avoided due to their lower fat and higher lactose content, leading puppies not only to retarded growth but also to digestive troubles. Higher lactose levels in bovine milk increase its osmolality, causing slower stomach emptying (and possible vomiting) and water absorption into the digestive tract (and thus diarrhea).

How to provide the milk replacer?

There are two methods of artificial feeding in puppies: bottle feeding and tube feeding. Although bottle feeding is time-consuming, it is much closer to natural feeding than the tube feeding technique. Suckling occurring during bottle feeding is not only relaxing for the newborn but also allows progressive secretion of the digestive enzymes. However, the suckling reflex is necessary for bottle feeding. The risk of aspiration pneumonia exists using this technique and to avoid it, the puppy should be held in the prone position and the size of the teat and its opening should be adapted to the size of the puppy.

If the suckling reflex is absent, the only alternative is tube feeding. The length and diameter of the tube should be adapted to the size of the puppy (usually French gauge 5 to 14). Also, the flexibility of the tube is an important criterion, with a risk

of mucous membrane irritation with a too rigid tube or of bending or coiling of the tip if it is too soft. Milk should be administered slowly (over about 1-2 minutes) to avoid the risk of bloating and colic (see chapter "Tube feeding guidelines").

How often to feed?

The administered volume, as well as the feeding frequency, should be adapted to the puppy or kitten's age and energy requirements. During the initial days of life, frequent feeding with a small volume is recommended. The volume is gradually increased with age. Administration of the maximal stomach volume should be avoided at the very early stage of life (see chapter "Tube feeding guidelines").

Puppy's age	Energy requirements/kg body weight	Feeding frequency
1st week	291 kcal	8 meals/day
2nd week	251 kcal	5 meals/day
3rd week	228 kcal	4 meals/day
4th week	185 kcal	4 meals/day

Problems linked to artificial feeding

Some side effects of artificial feeding are mentioned here together with ways to prevent them.

Disorder	Clinical signs	Prevention
Inappropriate feeding position	Choking, aspiration pneumonia	Sternal position with the head flexed (face down)
Incorrect temperature of the milk	Hypothermia (< 35 °C/95 °F) or indigestion if milk is too cold, burns if it's too hot	Ensure correct milk temperature (approximately 35 °C/95 °F)
Feeding too quickly	Vomiting, bloating, abdominal colic	Ensure appropriate size of nipple opening, feeding milk with a tube over 1-2 minutes
Inadequate mixing of the formula	Diarrhea, bloating	Dissolve the formula in warm water, mix thoroughly
Poor hygiene	Diarrhea, vomiting, infection	Clean the utensils regularly in hot water with detergent, avoiding reheating the milk from the last feeding

What else to do with the orphaned?

Orphans might have a decreased immune response secondary to stress and a lack of passive immunity in the absence of colostrum ingestion. Therefore, good hygiene of the nesting area, the carer's hands, and feeding equipment is imperative.

After feeding, it is mandatory to stimulate urination and defecation in the orphaned newborn by gently massaging the perineal area. Weight gain and body temperature should be monitored daily in all hand-reared puppies and kittens. In the event of hypothermia (below 35 °C/95 °F), milk formula should not be provided before warming the newborn. Peristalsis is slowed in hypothermic newborns, potentially leading to bacterial translocation and sepsis. The quality of feces should be monitored: healthy newborns have yellowish feces. A green or white color may indicate low digestibility of the milk replacer and a change of the milk brand should be considered.

Surrogate mother

If possible, fostering is a wonderful solution to improve the success of hand rearing. A surrogate mother can provide stimulation of the excretion reflex and helps in the thermoregulation of the neonates. A bitch or a queen with good maternal behavior can adopt orphans even if they are not the same age as their own offspring. Attention to the behavior of the dam during the adoption process and a slight age difference is vital to avoid neglecting or aggressive behavior toward the orphans.

Physical and mental development

Minimizing the stress of the orphans is important to improve their survival rate. Excessive stress can be detrimental to the development of the immune system. It is important to avoid overhandling and a noisy environment. As the orphans grow, it is essential to expose them to peers from the same species, especially for kittens. Abnormal behaviors such as anxiety, aggression, nervousness, and low capacity to adapt to new situations seem to be more often observed in kittens raised in isolation.

Although they are not orphaned, all neonates smaller and/or weaker than their siblings might benefit from an intervention similar to what is described above.

CLINICAL EXAMINATION OF THE NEWBORN

The clinical examination of unwell newborns is an emergency: they must be examined with the shortest possible delay after the appearance of the first sign(s), due to their propensity for rapid deterioration and death.

Preliminary steps

During examination, hypothermia and the risk of nosocomial contamination (problematic both for the newborn and for the kennel/cattery) must be limited.

- **Limit hypothermia:** newborns brought to the clinic should be kept warm (hot water bottle, microwaveable hot packs, etc.). The owner should be careful about the temperature of the device (risk of overheating and burning) and the risk of crushing (by rolling bottles for example). The time in the clinic's waiting room should be minimized as much as possible; clinical examination is conducted on a heated pad.
- **Strict hygiene:** contact with other animals and clients in the waiting room is strongly discouraged; the clinical examination is conducted on a disinfected surface (ideally on a disposable towel), and the newborn examined with gloved hands. The practitioner should also take care about his/her scrub suit avoiding any risk of cross-contamination.

Clinical examination should not be limited to the sick newborn, but should include the entire litter as well as the dam.

The mother: signs to check

- Vagina: presence of any purulent vaginal discharge or vesicles (suggesting Canine Herpesvirus 1 infection).
- Mammary glands: signs of mastitis, teat abnormality (do they permit suckling?), cleanliness, presence of active milk secretion.
- Any infection, with a specific focus on the reproductive tract, ears, teeth, and mammary glands.
- General health: rectal temperature (hyperthermia or not), appetite, maternal behavior (absence of any interest in the newborn or conversely restlessness and excessive interest in puppies are both potentially deleterious for neonatal health), body condition score (related to milk production).
- For queens: check the blood group (for the evaluation of the risk of isoerythrolysis in the kittens).

The newborns: signs to check

- If several newborns are examined, identify them individually (colored Velcro® or woolen collars, folded adhesive tape with a written number or name).
- **Vitality:** this is evaluated by the presence of spontaneous movements: crawling, suckling reflex, irritability reflex (pinching a limb extremity should initiate withdrawal), heart rate.
- **Congenital abnormalities:** even if the newborns are already several days old, congenital abnormalities must be checked (mainly hydrocephaly, spina bifida, cleft palate, and anal atresia).
- **Weight:** pay attention to the sensitivity of the scale (ideally to ± 1 g maximum) and the range of weights (ideally 50 g to 500 g or more). Weights are compared to the reference curves specific for the breed. Normal features are:
  - Over the first two days of life, no weight loss in puppies, and + 10 g/day in kittens.
  - Between day 2 and day 21: in puppies around 2-4 g per kg of expected adult weight per day; in kittens + 10-15 g/day.
  - Minimum milestones: in puppies, 1.5 times the birth weight on day 7 and 3 times on day 21; in kittens, 2 times the birth weight on day 9.

  Plotting daily weight into a breed/size specific reference growth curve will help monitor growth rate (see chapter "How to deal with low-birth-weight puppies and kittens?").

- **Hydration status:**
  - The persistence of a cutaneous fold is not informative in newborns.
  - Coloration of urine, usually nearly colorless, is indicative of dehydration when dark yellow.
  - Dehydration can be subjectively evaluated though the dryness of the oral mucosa, and objectively by the measurement of urinary specific gravity. Urine is collected into a 2 mL plain plastic tube by massage of the perineal region with a swab moistened with lukewarm water. A density higher than 1.030 measured on a medical refractometer is considered pathologic.
- **Temperature:**
  - Rectal temperature is measured with a pediatric electronic thermometer with a round tip. The normal temperature of the newborn is lower than the adult **(Table 1).** Hyperthermia can arise from an infectious or environmental cause (overheated newborns are hyperactive and cry). Infectious diseases most frequently result in hypothermia.

Table 1. Rectal temperature during the neonatal period.

Puppies Mean ± SD (95% of puppies are within mean ± 2SD)	At birth, around 33.6 ± 2 °C/92.5 ± 3.6 °F **Day 1 and 2:** 36.5 ± 1 °C/97.7 ± 1.8 °F **Day 7:** 37.0 ± 1.3 °C/98.6 ± 2.3 °F **Day 14-21:** 37.2 ± 0.5 °C/99.0 ± 0.9 °F
Kittens range	**Week 1:** 34.4-37.2 °C/93.9-99.0 °F **Week 2:** 35.0-37.8 °C/95-100.0 °F **Week 3:** 36.1-37.8 °C/97.0-100.0 °F

Important information about rectal temperature

- In hypothermia, the body temperature should be corrected progressively (1 °C/2 °F max/hour). Temperature in the incubator is thus increased progressively (+ 1 °C/+ 2 °F compared to the neonate's temperature) until it reaches 35-36 °C/95-96.8 °F with a recommended humidity of 55-65%.
- Oral feeding has to be delayed until the newborn has reached 35 °C/95 °F: hypothermia below 35 °C/95 °F induces an arrest of intestinal motility and low activity of digestive enzymes. As a consequence, milk would either accumulate in the stomach and/or not be digested but rather putrefy risking bacterial growth and death through septicemia.

- **Mucosa:**
  - Color: newborn mucosa are physiologically red rather than pink; a blue/gray color is indicative of hypoxia or septicemia; in kittens, an orange mucosa is characteristic of isoerythrolysis.
  - Dryness of the oral mucosa is indicative of dehydration.
- **Skin:** black/gray paws suggest septicemia.
- **Eye:** eyes normally open from day 10-15; if not, growth retardation can be suspected; palpebral swelling is indicative of neonatal ophthalmia in closed eyes.
- **Umbilicus:** delay in drying and falling off (normally within the first week) is indicative of an omphalitis/omphalophlebitis and possibly bacteriemia.

Repeated clinical examinations over time help to track the development of disease. The clinical improvement is evidenced first by the cessation of constant crying, improved vitality, and the normalization of rectal temperature. In the mid and long term, the normalization of growth is observed.

- **Cardiovascular system:**
  - Normal heart rate = 200-250 bpm. Bradycardia (100-150 bpm) is often associated with hypothermia. Since it is a protective mechanism, no drug aiming to increase cardiac rate should be administered.
- **Digestive tract:**
  - Has meconium been expelled?
  - Was the transfer of passive immunity, evidenced by weight gain or at least a constant weight between birth and day 2, achieved?
  - Is the suckling reflex present? It is crucial to decide between suckling/bottle feeding and tube feeding.
  - Note any abdominal distension and pain.
  - Note diarrhea, vomiting, constipation; any observable parasites in stools (such as *Toxocara);* were newborns (and dam) dewormed?
- **Respiratory tract:**
  - If the newborn has been bottle-fed, milk aspiration should be considered a potential cause of respiratory signs.
  - Auscultation is most often unrewarding; normal respiratory rate 30 rpm; note any dyspnea or oculonasal discharge.

A clinical examination can be completed by additional examinations such as blood biochemistry, ultrasound examination, and X-ray (see chapter "Other examinations of the newborn").

OTHER EXAMINATIONS OF THE NEWBORN

Various imaging and biological tests can help the veterinary surgeon to make an etiological diagnosis, as well as monitoring the neonate's condition. The tests are easy to perform, but it is important to be aware of the age-related particularities so as not to misinterpret them.

Neurological examination

- The eyelids and ear canals open between 10 and 15 days old. A strong light directed at the eyes causes a slow blink reflex.
- The newborn reacts to noises.
- Flexion is the predominant posture at birth, replaced by extension after 4-5 days.
- Sucking and rooting reflexes should be present at birth.
- Other reflexes at different ages **(Table 1).**

Table 1. Neurological development: posture, cranial nerves (CN), peripheral nerves of the puppy/kitten.

Neurological function	Age of onset
Vestibular system, head carriage	Present at birth (necessary for suckling)
Voluntary movements of the front legs	Present from day 5 to 6
Voluntary movements of the hindquarters	Present from day 7 to 10 Supports weight from day 14 to 16
Locomotion	Coordination acquired between 6 to 8 weeks
Tactile placement on forelegs	Present from day 2 to 4
Tactile placement on hindquarters	Present from day 5 to 9
Photomotor reflexes (CN II/III)	As soon as the eyes open (day 10 to 16 in puppies, day 5 to 14 in kittens)
Blink response to threat (CN II/VII)	Rarely present before 3-4 weeks
Palpebral reflex (CN V-VII)	Present from day 2 to 4 (puppies) Present from day 1 to 3 (kittens)

Ultrasonography

Indications

Ultrasound, unlike radiography, is the examination of choice for the evaluation of the abdomen, heart, and thorax of young animals (< 8 weeks of age). The absence of fatty tissue and the small volume of the animal facilitate visualization of all the organs.

In the wasting syndrome of newborns, an ultrasound examination can sometimes reveal organ lesions.

We look primarily for intussusception/invagination, inflammation of the abdominal organs (liver, kidney, or lung abscesses in sepsis), portosystemic shunt, signs of renal dysplasia, ectopic ureter, persistence of the urachus canal, and cardiac malformation.

Methods

Equipment: high frequency probes are preferred (> 7.5 MHz). Convex or semi-convex probe preferred.

Procedure

- Similar to examination in adults.
- Ensure maintaining body temperature.

Interpretation

Some images suggesting pathologies in adults can be normal in newborns:

- Presence of a discrete intra-abdominal effusion (anechoic) **(Figure 1).**
- Large liver.
- Slightly enlarged pelvic cavities.

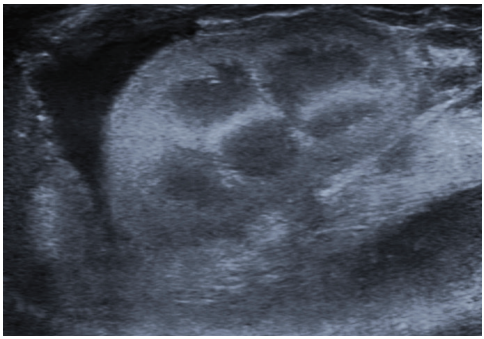


Figure 1. Physiological ascites.

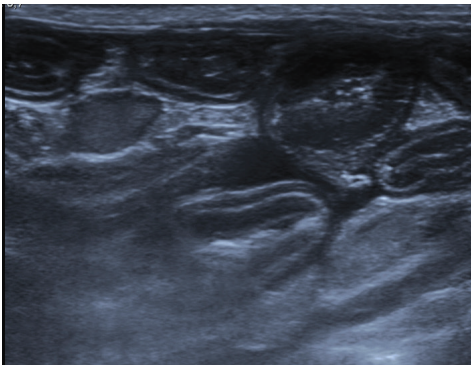


Figure 2. Abdominal ultrasound with ascarid enterocolitis. Note the presence of ascites and the clearly visible mesenteric lymph node.

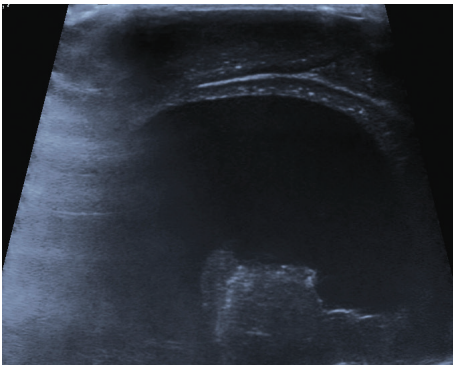


Figure 3. Hydrocephalus. Dilation of the lateral ventricles.

- Mesenteric nodes developed and clearly visible **(Figure 2).**
- Heart: see list of conditions.
- Brain visible through the opening between the fontanella **(Figure 3).**

X-ray

This section will discuss the main differences in the interpretation of radiographic images in young compared to adult animals.

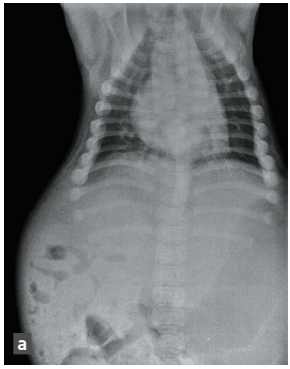
However, whenever possible, radiographs should be compared to that of another (healthy) littermate in case of doubt about interpretation (thorax and abdomen). In the case of orthopedic radiographs, it is recommended to compare the affected with the contralateral limb.

Thorax

- Heart
  - Kitten: its size should be at least 2 inter-costal spaces (ICS) on a latero-lateral view, with a clear space between the apex and diaphragm.
  - Puppy: brachycephalic breeds (Bulldog, English Bulldog, etc.): 3.5 ICS **(Figure 4a).** Dolichocephalic breeds: 2.5 ICS.

- Thymus
  - Visible until 4 to 6 months. A triangular sail shape, in the cranial mediastinum, slightly to the left in ventro-dorsal. On lateral view, it may be mistaken for pleural effusion anterior to the heart **(Figures 4b and 5).**
- Trachea
  - If displaced ventrally, this is consistent with dilatation of the esophagus. The trachea may appear small in diameter (especially in brachycephalic breeds) during growth, but gradually enlarges to normal size in adulthood.
- Abdomen **(Figure 6a)**
  - Little contrast compared with adults: little adipose tissue, brown fat (more water-like than adult adipose tissue), more fluid, large abdomen.
  - Adult appearance around 6 months of age.
  - Kidneys appear late, from 3 months of age.
  - Liver of the newborn is wider than in the adult, extending well beyond the ribs on a latero-lateral view. The contours are difficult to delineate (not enough fat in the falciform ligament).
  - Microhepatism (in case of a shunt) may be suspected if the stomach (filled with gas) is displaced cranially (compared to another sibling).
- Skeletal system **(Figure 6b)**

Difficult interpretation due to active ossification process during growth.
  - Tips:
    - Compare with the contralateral limb if a lesion is suspected on one side.
    - Compare with another animal in the litter (or an individual of the same breed and age) if symmetrical lesions are suspected.



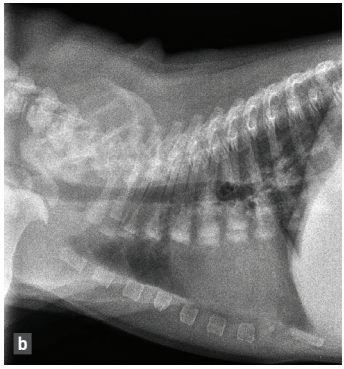


Figure 4. Normal thorax of a 4-week-old puppy.

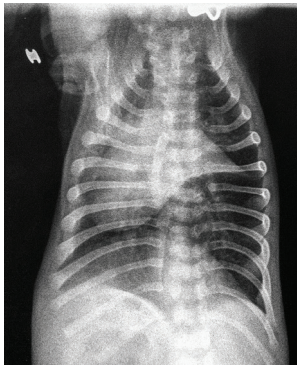


Figure 5. Note the thymus which is radiopaque and particularly visible in this puppy with a systemic inflammation.

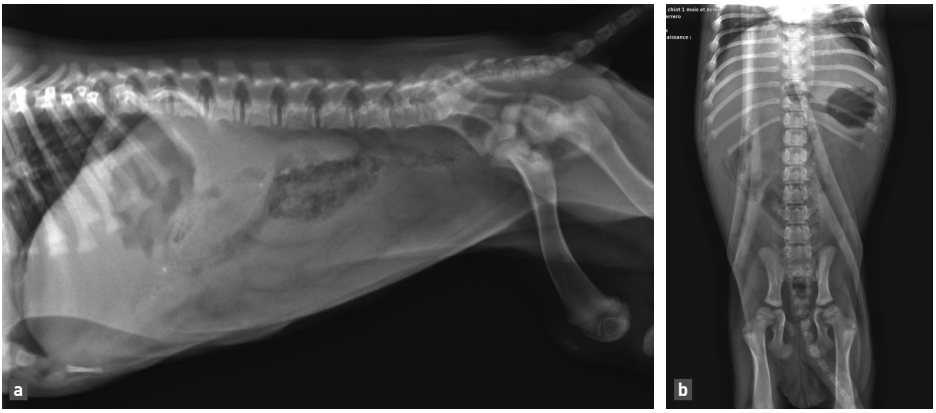


Figure 6. Normal 6-week-old puppy.

- Joints appear enlarged and soft tissues swollen.
- At birth, only the primary ossification centers of the long bones are visible (diaphysis).
- The secondary ossification centers (epiphyses and apophyses) are not visible: olecranon, calcaneus, cuboids.

The locations of the secondary centers should be known to avoid confusion with fracture lines: supraglenoid and glenoid tubercle of the scapula, medial epicondyle of the distal humerus, lateral malleolus of the distal fibula, tibial tuberosity, apophysis of the calcaneus tuberosity.

- The bones of the secondary centers may appear irregular during their rapid growth. Their appearance should not be confused with sepsis or osteochondritis.
- Particular attention should be given to the radiographic appearance of the spine of the immature skeleton.
  - The vertebrae initially appear as blocks with very large spaces between them.
  - The vertebral epiphyses are initially bulging, concave in shape, and become straight as the ossification process proceeds. Bulging plateaus during growth should not be confused with a metabolic disease that may have a similar appearance (hypothyroidism, growth hormone deficiency, nutritional hyperparathyroidism).
- Once the secondary sites of ossification are nearly mature, the epiphyses and apophyses can be assessed: Salter-Harris type fracture, sepsis, valgus or varus, delayed closure (sterilization, metabolic disorder).

- It is important to note that a cartilaginous lesion on a physis will not be visualised until it has ossified and/or caused deformities or delayed growth.
- Congenital anomalies or certain growth disorders can be very difficult to diagnose as they are often symmetrical and/or generalized: secondary hyperparathyroidism (nutritional or renal), hypothyroidism, cartilage matrix anomalies (Scottish fold), dwarfism.

Biochemistry

- Urine analysis:
  - Indication:
    - Hydration status of the newborn.
    - Suspected renal failure (dysplasia, intoxication, etc.).
    - Suspicion of congenital endocrine disease (diabetes insipidus).
  - Equipment: urine dipstick, refractometer, and dry tube.
  - Collection of urine by perineal stimulation (< 3-4 weeks of age) or at spontaneous micturition or cystocentesis (bacteriology).
  - Interpretation:
    - Physiological proteinuria < 3 weeks (colostral antibodies).
    - Physiological glucosuria < 3 weeks (immature renal function).
    - SG: 1.006 to 1.017 during neonatal period. Adult SG reached between 11 (puppy) and 19 (kitten) weeks.
    - Urinary phosphorus:creatinine ratio high (< 3 weeks).
    - Bacteriology: same as adult.
- Blood biochemistry and hematology (see "Appendix").

HOSPITALIZATION OF THE NEWBORN

As newborn animals can deteriorate very rapidly from even mild symptoms, hospitalization and intensive care provide the optimal environmental conditions for survival and medical support in the form of tube feeding, intravenous fluids, and drug administration. This is particularly important in cases of dehydration and hypothermia. In the event of death, the necessary sampling and postmortem procedures can be undertaken without delay.

Which animals to hospitalize?

- Any sick newborn.
- The littermates, for the early detection of clinical signs and rapid care. However, this creates a risk of nosocomial infections and difficulties for lactation management (if the whole litter is separated from the dam and do not suckle for several days).
- Hospitalization of the dam decreases the time dedicated to newborn nursing (feeding, micturition, and defecation management) but makes it impossible to administer intravenous fluids.
- Usually, only the sick newborn is hospitalized; the littermates and the dam are kept at home.

Where to hospitalize?

Ideally in a separate ward – to reduce the risk of nosocomial infections and the stress associated with noise – in an incubator (either a veterinary or a human incubator, or a home-made incubator using an aquarium for example). Temperature is kept in the range of 28-37 °C/82.4-98.6 °F. Oxygen provision should ideally be available, together with humidity control maintained at ~50-60%.

Hygiene

The incubator should be carefully disinfected between patients. Single-use consumables are encouraged. Commercial milk replacers should be kept under the correct conditions. Hospitalized newborns should be handled with clean gloves on a disinfected heated surface (37 °C/98.6 °F) **(Figure 1).**

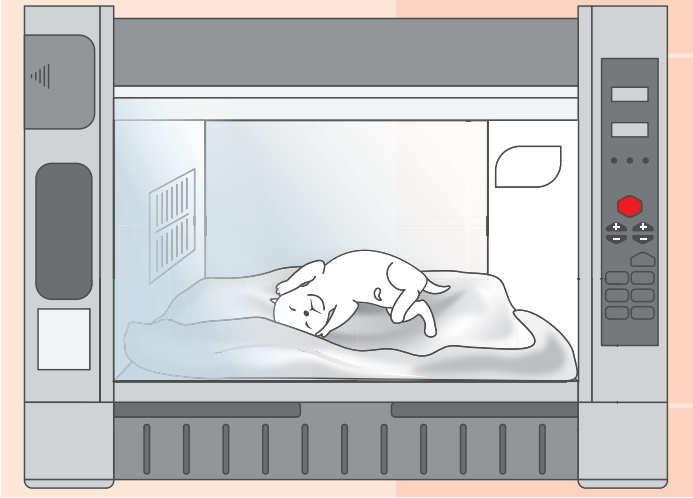


Figure 1. A professional incubator facilitates the control of temperature and humidity in high hygiene conditions.

Importance of nursing during hospitalization

Even though the apparent cause of the disease is often bacterial, the situation is exacerbated by hypothermia, hypoglycemia, dehydration, and hypoxia. Without appropriate nursing, medical treatments will be ineffective.

One main difficulty for the practitioner is the time required for newborn nursing at the clinic. Appropriate training of nurses is especially helpful in providing optimal care.

- **Environmental temperature:** 28-30 °C/82.4-86 °F during the first week of life, 26-28 °C/78.8-82.4 °F in the second. To be adapted to the actual rectal temperature of the newborns, with the objective of achieving 35-36 °C/95-96.8 °F. Warming has to be performed slowly, with the temperature of the incubator set at +1 °C/+2 °F above that of the newborn and checked every hour. Note that incubators can heat but do not cool (they cannot achieve a temperature below the ambient temperature).
- **Hygrometry:** 60%, to limit fluid loss through skin and respiratory tract.
- **Feeding**
  - What: colostrum or colostral substitute (if hospitalized during the first 8 hours of life); otherwise, commercial milk replacer.
  - How: by bottle feeding or orogastric tube feeding.
  - How much: 1.5 mL colostrum/100 g body weight minimum; for commercial milk, see the manufacturer's instructions (in general ~20% body weight over 24 hours, with a maximum of 4-5 mL/100 g body weight per meal for puppies and 3-4 mL for kittens).
  - How many meals: colostrum or a substitute as early as possible during the first 8 hours of life; commercial milk is given in 6 meals per day over the first week of life then 4 meals per day.
- **Defecation and micturition** should be induced by perineal stimulation using a moistened swab before and most importantly after each meal.

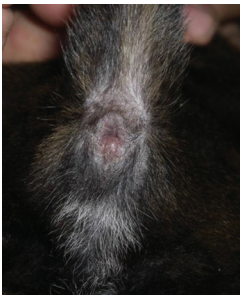
Infusion in the newborn

- Ensure restraint is efficient but non-forceful; short volatile anesthesia, provided through a pediatric mask, is useful and safe.
- Cutaneous analgesia can be additionally provided (cream containing a local anesthetic such as lidocaine and prilocaine applied after shaving and covered by a plastic dressing for 20 minutes).
- Perfusion can be provided intravenously (cephalic or jugular vein; 22G or 24G catheter) or intraosseously (into the trochanteric fossa of the femur or the tibial tuberosity; 18G to 22G spinal needle or injection needle), and is to be preferred over intraperitoneal. If a parenteral route cannot be accessed, subcutaneous injections of small volumes in several places can be an alternative (hypertonic solutions are contraindicated). Oral rehydration is usually insufficient.
- Immersing the drip tube in warm water will not raise the temperature of the fluids before they reach the newborn's bloodstream.
- Overhydration is a major risk in newborns. Infusion is best controlled by a syringe pump. The basic flow rate is one bolus of isotonic solution (Lactated Ringer; 3-4.5 mL/100 g puppy and 2-3 mL/100 g kitten), followed by a constant rate infusion of 3-4 mL/kg/h for maintenance.

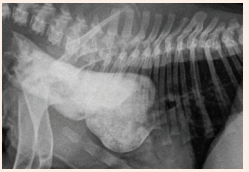
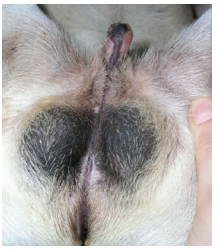
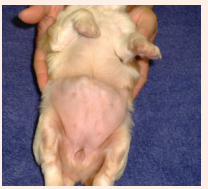
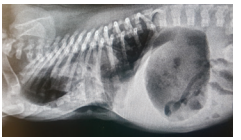
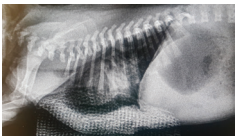
During the period of hospitalization, the newborn's health status and response should be checked at least every day, ideally twice a day (due to possible rapid deterioration), taking pictures and/or short videos if possible to share with the owner.

CONGENITAL ABNORMALITIES

There are many congenital malformations that can affect the various organs and systems of the body. The majority are very rare, and many are not curable. In the table, the most common abnormalities are discussed.

Congenital disorder	Frequency	Breed predisposition	Etiology
Anal atresia 	Rare	Poodle, Boston Terrier, Boxer, Rottweiler	Congenital, inherited?
Anasarca 	Common	English Bulldog	Inherited disorder, circulatory deficiency, unknown.
Cleft palate	Common	Boxer, French Bulldog, English Bulldog, Cavalier King Charles, West Highland White Terrier, Collie and Bearded collie, German Shepherd and Chihuahua, Siamese	Lack of tissue in the roof of the mouth resulting in a communication between the oral cavity and the nasal cavity (hard palate, soft palate or both); this anomaly is related to a neural tube closure anomaly. There are several causes, but low folic acid intake during pregnancy seems to play an important role.

Clinical manifestations / Diagnosis	Treatment	Prevention
4 stages (I, II, III, IV): **I**. Anal stenosis or presence of a very thin membrane. **II**. Imperforate anus: presence of a thick cloacal membrane. **III**. Discontinuous rectum with anal imperforation. **IV**. Absence of proximal rectum but normal anal and terminal rectal development. The presence of a functional external anal sphincter should be assessed before surgical correction is undertaken: pinching of the penile bulbs or vulvar lips should induce contraction of the anal region (bulbourethral reflex). If this reflex is absent (types III, IV, and sometimes type II), euthanasia should be recommended.	Excision of the stricture for types I and II. Very complicated for stage III and IV. Non-surgical management may also be applied for type I cases *(i.e.*, balloon dilatation).	None
Edema over the entire body, especially in the head and neck. Sometimes edema of the fetal annexes. In severe cases, abdominal and thoracic fluid may be present (leading quickly to death).	Treatment is not necessary if the edema is mild. Euthanasia in severe hydrops (> 30% of the offspring's weight). Diuretics (furosemide: 1-2 mg/kg IM q2h), ensuring that the puppy urinates every 30 minutes by stimulating the perineal area.	Treating placental insufficiency, genetic selection.
From the very first feed: sneezing, coughing, milk flowing out of the nose, breathing difficulties, dysphagia, sucking difficulties leading to delayed growth. Confirm that the soft palate is indeed not sealed.	Medical management of infectious complications. Nutritional support by tube, sponge or parenteral feeding until solid food intake or surgery is possible (usually not before 3 to 4 months). A palatal brace left in place during feeding is also a possibility. Surgical: see surgical techniques.	Parent selection in a high-risk breed Folic acid: 5 mg/d from the beginning of heat to the 6th week of pregnancy (not effective in all breeds).

Congenital disorder	Frequency	Breed predisposition	Etiology
Crico-pharyngeal achalasia	Rare	Cocker Spaniel, Golden Retrievers	Inability of the upper esophageal sphincter to relax and allow the passage of a food bolus into the proximal esophagus.
Megaesophagus 	Rare	Irish Setter, Great Dane, German Shepherd, Shar-Pei, Miniature Schnauzer, and Fox Terrier. Siamese	A defect in the vagal innervation of the esophagus is suspected.
Hypospadia 	Rare	Boston Terrier	Often associated with male pseudo-hermaphroditism or testicular feminization syndrome, administration of progestogens or androgens during pregnancy, vitamin A deficiency during pregnancy. It is most often idiopathic. Cryptorchidism, micropenis, and ventral deviation of the penis are often associated.
Umbilical hernia 	Frequent	May appear in all breeds	Non-closure of the white line. Cause unknown most of the time. Excessive traction on the umbilical cord may exacerbate the problem.
Pectus excavatum  	Rare	English Bulldog, Burmese	Deformity of the cartilaginous portion of the ribs and sternum which results in a dorsoventral narrowing of the thorax.

Clinical manifestations / Diagnosis	Treatment	Prevention
Poor growth, regurgitation, bronchopneumonia/ Fluoroscopy.	Cricopharyngeal +/- thyropharyngeal myotomy or myectomy. 65% success rate.	None
Persistent regurgitation at weaning (sometimes vomiting). Weight loss, malnutrition, respiratory distress, and hyperthermia secondary to bronchopneumonia. Chest X-ray: without and with contrast medium (barium transit).	Antibiotic therapy if bronchopneumonia (consider parenteral route). Division of meals and feeding at head height. Surgery is not very effective.	None
Clinical diagnosis: incorrect implantation of the urethral orifice in the ventral region of the penis. The urethral orifice may be located in the penile, scrotal, or, more commonly, perineal region. Clinical signs: asymptomatic, urinary incontinence, urinary infection, inguinal dermatitis, infertility.	None if asymptomatic. Ureterostomy and penile amputation if penile hypospadias. Closure of hypospadias on catheter if limited. Catheter is left in place during the entire healing process after the urethral reconstruction to limit shrinkage.	Unknown
The omentum and small intestine are the main organs herniated.	Hernias of less than 1 cm may close spontaneously by 4-6 months of age. Surgical closure is recommended for large hernias.	Unknown
Completely asymptomatic but sometimes associated with respiratory and/or cardiovascular dysfunction: exercise intolerance, dyspnea, cyanosis. Cardiac arrhythmia, heart murmur. Diagnosis: clinical signs, X-ray, ECG.	Usually not necessary. Bottle feed in a standing position in first weeks of life. A thoracic corset is very effective.	None

CLEFT PALATE AND ITS SURGICAL CORRECTION

Cleft palate is the most common congenital disease, characterized by a lack of tissue in the roof of the mouth resulting in a communication between the oral and nasal cavities (hard palate, soft palate, or both).

Cleft palate is an anomaly of the neural tube closure that occurs between the 25th and 28th day of pregnancy. There are several causes, but low folic acid intake seems to play an important role **(Figure 1).**

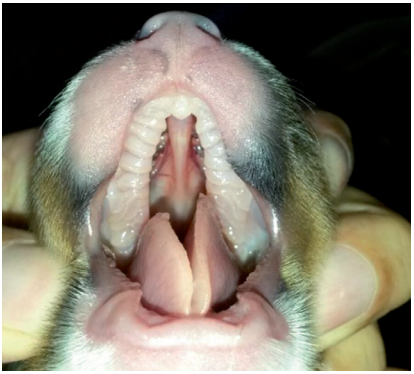


Figure 1. Puppy with a severe cleft palate.

Clinical manifestations

Diagnosis

- From the very first feeding: sneezing, coughing, milk flowing out of the nose, breathing difficulties (dysphagia), sucking difficulties leading to poor growth. Confirm that the soft palate is indeed not sealed.
- Very large cleft palates generally lead to euthanasia or death of the animal before surgery time (difficulty suckling, aspiration pneumonia).

Treatment

- Medical management of infectious complications.
- Nutritional support by tube, sponge, or parenteral feeding until solid food intake or surgery is possible (usually not before 3 months). A palatal brace left in place during feeding is also a possibility.
- Surgical: see below.

Prevention

- Parent selection in a high-risk breed.
- Folic acid: 5 mg/d from the beginning of heat to the 6th week of pregnancy (not effective in all breeds).

Surgical correction of cleft palate

Surgical correction is not recommended before 8 to 12 weeks, due to an increased risk of wound dehiscence, and disturbance of maxillofacial growth.

Specific equipment required:

- Periosteal elevator.
- 4-0 Mid-term/long-term monofilament absorbable (Biosyn®).

Unilateral (or bilateral) mucosal reversal flap technique (most efficient, less dehiscence) (Figure 2):

- Measure the width of the cleft to determine the size of the flap required to fill the defect. Add 4 to 5 mm to the measurement.
- Incise the mucosa and periosteum laterally and parallel to the edge of the cleft, respecting the distance measured to the cleft.
- Using a periosteal elevator, lift and peel back the mucosa and underlying periosteum towards the fistula.
- Caution: advance carefully towards the junction between the nasal and buccal mucosa so as not to cut the epithelium or damage the vascular supply, especially the major palatal vessels.
- At this stage, it should be possible to orient the flap without tension to cover the cleft.
- On the opposite side of the cleft, make another incision along the cleft 3-5 mm distant and elevate the mucoperiosteal tissue laterally so that the contralateral turning flap can slide under the mucoperiosteal tissue.
- Suture the tissues together with 4-0 absorbable monofilament (knots must rest on the bone).
- The exposed palatal bone is covered with granulation tissue within 48 hours. The sutures will resorb within a few weeks.
- It is not necessary to tube feed the animal in the following days.

Pedicle flap technique (not recommended in large cleft palate > 4 mm width).

The pedicle flap technique is possible (and easier to perform), but the sutures have no bone support and dehiscence is more frequent. This technique should only be used for very narrow slits.

- Incise the mucosa and periosteum along the length of the hard palate on the lateral edges of the palate.
- With a periosteal elevator, lift and loosen the mucosa and underlying periosteum towards the fistula. Be careful to preserve the palatal artery on both sides.
- Excise the margins of the palatal tissue opposite the cleft.
- Suture in single stitches in two planes to optimize apposition and limit dehiscence. There should be no tension when suturing.

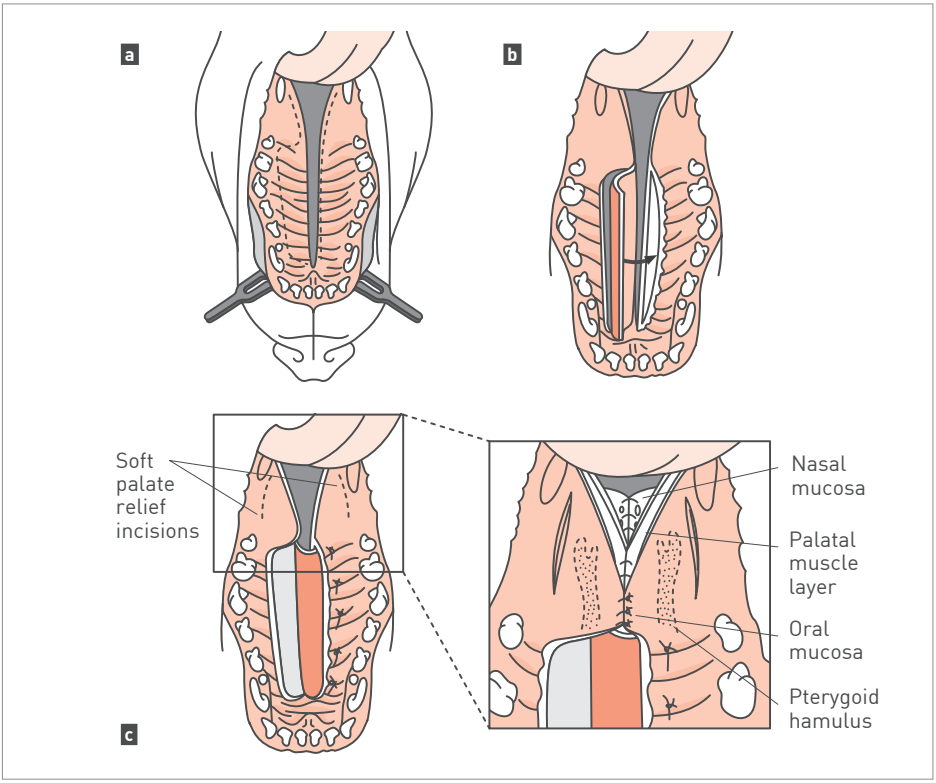


Figure 2. Cleft palate may be repaired with an overlapping flap technique. **(a)** The dotted lines represent the incisions necessary to allow soft tissue closure. **(b)** Elevate the mucoperiosteal flap and rotate it medially to cover the hard palate defect. **(c)** Complete the repair by apposing the incised edges of the cleft soft palate in three layers.

SWIMMER PUPPY SYNDROME

Swimmer puppy syndrome, also known as swimming-puppy or flat-puppy syndrome, is a locomotion difficulty observed in puppies from 2 to 4 weeks of age, and exceptionally in kittens who are unable to bring their limbs under themselves (hind limbs > front limbs).

Potential causes

Although no precise cause has been identified, several hypotheses have been put forward: overweight secondary to overconsumption, unsuitable nursing area (smooth floor without grip or too high a temperature favoring immobility), delay in maturation of the nervous system (myelination of peripheral nerves), taurine deficiency, genetic cause, herpesvirus infection, deficiency in selenium absorption, etc.

Many breeds can be affected: mainly chondrodystrophic breeds (Cavalier King Charles, French Bulldog, and English Bulldog), but also Labrador and Golden Retrievers, English Cocker Spaniels, and West Highland White Terriers. Few cat breeds are predisposed: Persian and Exotic shorthair.

Clinical signs

The puppies/kittens are unable to stand at 2 weeks of age and unable to move at 3 weeks of age. It generally affects the hindquarters and sometimes all limbs.

Initial stage: splayed limbs **(Figure 1).**

Advanced stage: dorsoventral flattening of the thorax **(Figure 2),** patella luxation, crawling movements, dyspnea, regurgitation, dysphagia, rubbing skin lesions.

Figure 1. Puppy with splayed hind legs that prevents him from standing up on all 4 legs.

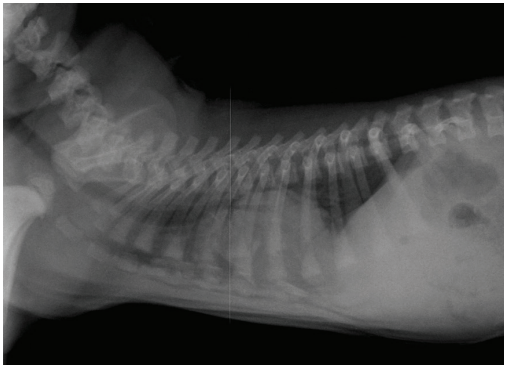


Figure 2. Chest X-ray showing flattening of the sternum due to persistent swimmer puppy syndrome.

Diagnosis

Mainly clinical:

Diagnosis is often made early because the syndrome affects only one or two individuals in the litter. In case the entire litter is affected, the diagnosis may happen later as the owner is not aware of the disease at the initial stage.

This disease must be differentiated from others affecting the nervous system: distemper virus, neosporosis, toxoplasmosis, myopathies, spina bifida, etc.

Treatment

- Use a rough floor surface (blanket, carpet, egg tray, etc.).
- Functional rehabilitation: mobilize the puppy's limbs, carry out muscle massages, use hydrotherapy, stimulate the innervation of the limbs (toothbrushes under pads).

- Make the puppy walk in a corridor the width of its shoulders **(Figure 4);** and/or place a tie between the forelimbs (with 5 cm of space, between the elbows and the carpus) **(Figure 3).**
- Medication might be helpful although there is no scientific consensus: Selenium: 0.023 mg to 0.09 mg/kg q24h. Maximum 4 administrations. Route of administration according to the galenic form.

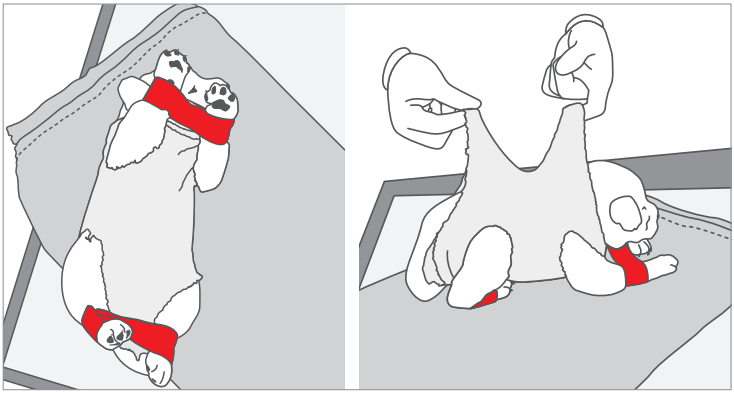


Figure 3. Placement of handcuffs on the puppy to facilitate rehabilitation of the limbs by preventing them from spreading apart.

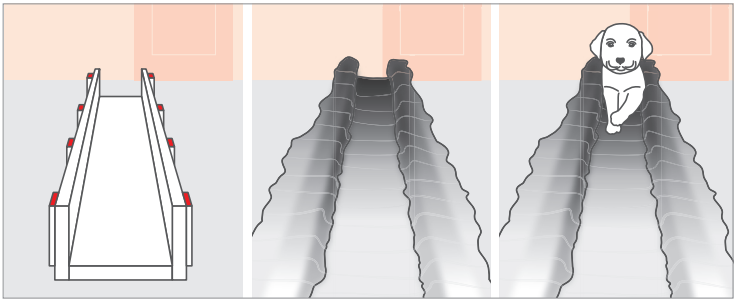


Figure 4. Creation of a rehabilitation corridor where the puppy can walk and lie down while maintaining its limbs.

Prognosis

- Excellent if treated early: > 90% cure.
- More reserved if complications of bronchopneumonia due to dysphagia, and significant deformation of the thoracic cage.

MAIN CAUSES OF NEONATAL DISEASE IN PUPPIES AND KITTENS

The vulnerability of newborn puppies and kittens is related to their risk of hypoxia during birth (mostly puppies), their immaturity at birth, and any deficit of passive immune transfer (in both puppies and kittens).

Morbidity and mortality are frequent

The average neonatal mortality rate (death within the first 21 days of age) in puppies and kittens is 15-20%, but can vary from 5% to 40% depending on the breed and the sanitary conditions in the breeding kennel or cattery. The vast majority of newborn fatalities (about 75%) become sick and die within the first week after birth. The morbidity rate is even higher; 34% of kennels declare a morbidity in at least one litter, most often due to an infection or inflammation.

Clinical signs

Disease progress is very rapid in newborns and the clinical signs are usually non-specific. In the majority of neonatal conditions, puppies and kittens present hypothermia (rectal temperature < 34 °C/93.2 °F), hypoglycemia [glucose < 2.22 mmol/L (40 mg/dL)], and dehydration (dry mucous membranes). However, some specific clinical signs may be also observed depending on the cause of the disease.

Hypoxia

Hypoxia is the most common non-infectious disorder in newborn dogs. Puppies and kittens suffer from hypoxia after a complicated birth, presenting most commonly with cyanosis, dyspnea, and tachypnea observed immediately after birth. Prolonged low oxygen tension may lead to aspiration of the amniotic fluid, and damage to the intestinal mucosa, adrenal cortex, heart, and brain tissues. APGAR score and blood lactate can be evaluated at birth in order to identify

newborns suffering from hypoxia. Antibiotic therapy should be considered in those individuals, as hypoxia predisposes to bacterial translocation.

Sepsis

Bacterial infections are observed in 40-65% of dying puppies and kittens, with *Escherichia coli*, *Streptococcus* spp., and *Staphylococcus* spp. most commonly isolated from sick neonates, although some specific infections may also be observed *(e.g.*, *Salmonella* spp.). Indeed, any condition leading to even transient hypoglycemia or hypothermia may induce bacterial translocation from the mucous membranes to the blood, leading to sepsis, which is lethal in the majority of cases. Clinical signs, if present, are very non-specific, such as fading, anorexia, diarrhea, and vomiting. The diagnosis is most often based on postmortem examination and bacterial culture of internal organs. In a suspected bacterial infection in a live puppy or kitten, oral and/or rectal swabs may be collected for bacteriological examination. In the case of a positive pure culture, antibiotic therapy should be provided following the sensitivity result.

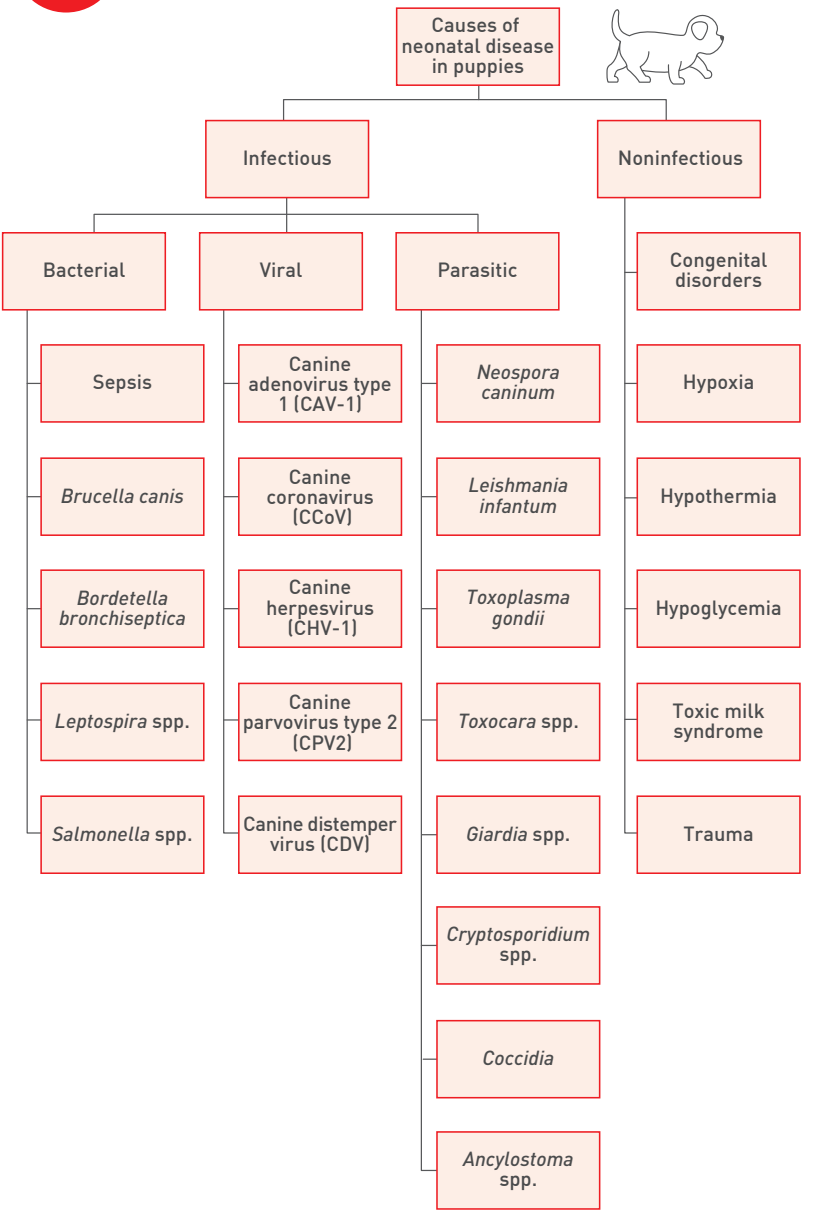
Respiratory disorders

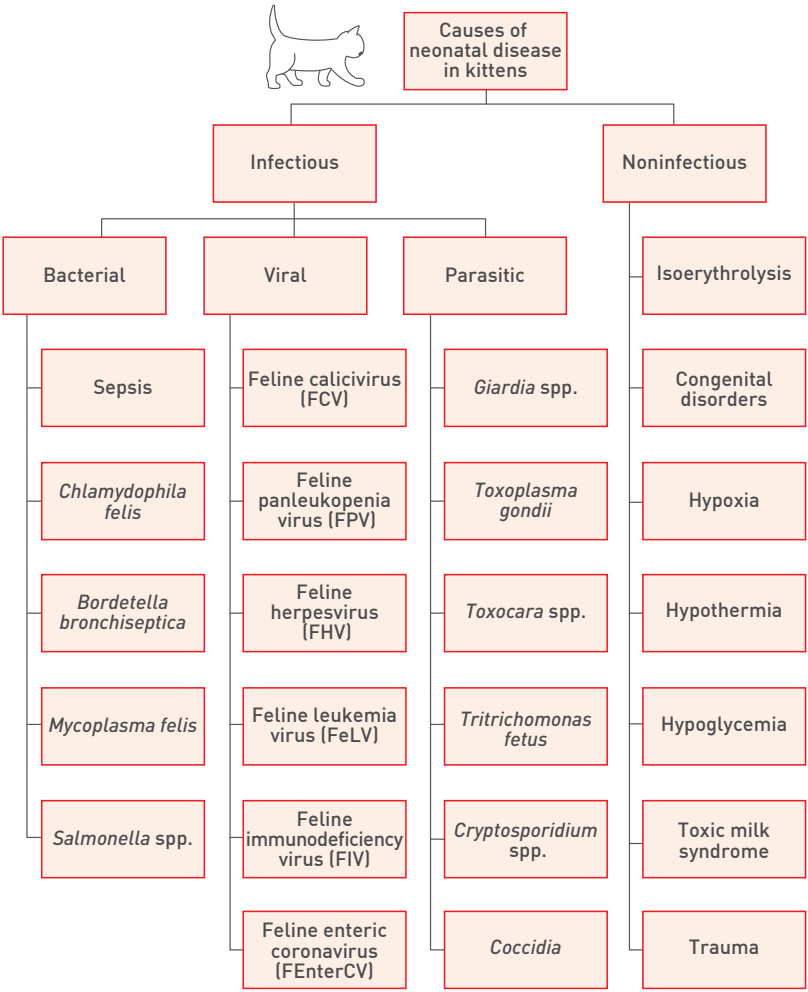
In both puppies and kittens, respiratory signs and lesions are commonly observed during the neonatal period: almost 50% of kittens present signs of acute upper respiratory infection before dying and almost 50% of puppies present lesions such as pneumonia or bronchopneumonia, pulmonary hemorrhage, or pulmonary aspiration on the postmortem examination. Lung immaturity in preterm puppies and kittens, and low local immunity, predisposes newborn puppies and kittens to respiratory disorders. However, their origin remains unclear in both species, with only a few organisms being identified as strict pathogens with a respiratory tropism. The pathogens most commonly identified in newborn puppies with respiratory disorders are canine herpesvirus type 1, canine adenovirus type 2, and *Bordetella bronchiseptica*. In kittens the main pathogens are feline calicivirus (prevalence of 19%) and feline herpesvirus (prevalence of 14%). Diagnosis in the live animal may be reached from nasal, ocular, or oropharyngeal swabs; in dead newborns, it can be diagnosed from a PCR analysis of the lungs.

Diarrhea syndrome

Diarrhea is very common in newborns, although it may be a non-specific sign, such as observed in toxic milk syndrome, canine herpesvirus infection, and sepsis. It can be specifically linked to digestive tract disorders such as food indigestion, food intoxication *(Salmonella* spp.), or the presence of enteropathogens *(e.g.*, *coccidia, ancylostoma, cryptosporidium, Toxocara).* Whatever the origin, diarrhea may lead to rapid dehydration of the newborn, followed by hypoglycemia and hypothermia. Thus, all cases of neonatal diarrhea should be quickly investigated to elucidate its potential cause. Firstly, the dam should be examined for any inflammatory reproductive tract disorders. Questions concerning feeding methods should be explored to exclude maldigestion or intoxication. If there is suspicion of an infectious cause, fecal culture and PCR analysis would be desirable to identify the responsible agent.

Major causes of morbidity





In general, we can distinguish two main causes of morbidity in puppies and kittens: infectious due to bacterial, viral, or parasitic pathogens and noninfectious ones.

Diagnosis of some common infectious agents observed in newborn puppies

Pathogen	Disease	Sampling mode	Tissue to be harvested
Canine adenovirus type 1 (CAV-1)	Infectious canine hepatitis	Dry tube	Liver, kidney bronchoalveolar liquid
Canine coronavirus (CCoV)	Enteritis (enteral strain) enteritis, pneumonia (pantropic strain)	Dry cotton swab	Rectal swab
Canine herpesvirus (CHV-1)	Stillbirth Diffuse multifocal hemorrhage	Dry tube or dry cotton swab	Liver, kidney, spleen, lung, oropharyngeal swab
Canine distemper (CDV)	Pneumonia, enteritis, encephalitis	Dry tube	Liver, kidney, lung, blood
Bordetella bronchiseptica	Bronchopneumonia	Dry tube or dry cotton swab	Lung, nasal swab
Canine parvovirus type 2 (CPV-2)	Myocarditis, enteritis	Dry cotton swab	Rectal swab
Canine minute virus (CPV-1)	Enteritis, pneumonia, myocarditis	Dry tube or dry cotton swab	Liver, kidney, spleen, lung, rectal swab
Cryptosporidium spp.	Enteritis	Dry cotton swab	Rectal swab
Giardia spp.	Enterocolitis	Dry cotton swab	Rectal swab
Brucella spp.	Stillbirth, lymphadenomegaly, splenomegaly	Dry tube	Liver, kidney, spleen, lung, blood
Neospora caninum	Encephalomyelitis, myositis, myofibrosis	Dry tube	Brain, muscle, cerebrospinal fluid
Toxoplasma gondii	Stillbirth, meningoencephalomyelitis, myositis	Dry tube	Brain, muscle, cerebrospinal fluid

Diagnosis of some common infectious agents observed in newborn kittens

Pathogen	Disease	Sampling mode	Tissue to be harvested
Feline calicivirus (FCV)	Severe upper respiratory infection, gingivitis, pneumonia	Dry tube or dry cotton swab	Liver, kidney bronchoalveolar liquid, oropharyngeal and conjunctival swab
Feline herpesvirus (FHV)	Rhinotracheitis, corneal ulcers, pneumonia	Dry tube or dry cotton swab	Liver, kidney bronchoalveolar liquid, oropharyngeal and conjunctival swab
Mycoplasma felis	Upper respiratory infection, conjunctivitis, pneumonia	Dry tube or dry cotton swab	Liver, kidney bronchoalveolar liquid, oropharyngeal and conjunctival swab
Bordetella bronchiseptica	Bronchopneumonia	Dry tube or dry cotton swab	Lung, nasal swab
Chlamydia felis	Conjunctivitis	Dry tube or dry cotton swab	Liver, kidney conjunctival swab
Feline parvovirus (FPV)	Ataxia (at birth), enteritis (later in life)	Dry cotton swab	Rectal swab
Feline coronavirus (FCoV)	Enteritis	Dry cotton swab	Rectal swab
Cryptosporidium spp.	Enteritis	Dry cotton swab	Rectal swab
Giardia spp.	Enterocolitis	Dry cotton swab	Rectal swab
Toxoplasma gondii	Stillbirth, meningoencephalomyelitis, myositis	Dry tube	Brain, muscle, cerebrospinal fluid

EARLY MARKERS OF NEONATAL MORTALITY

The newborn puppy and kitten undergo some important changes when passing from intra to extrauterine life. For instance, they need to adapt to obtaining oxygen and maintaining their body temperature and blood glucose levels. This is also the period of passive immune transfer via colostrum intake and gut development allowing food digestion and absorption. Thus, the first 48h of life are crucial for survival.

How to monitor newborns from birth?

Some simple methods of monitoring can be used during the first weeks of life to identify newborns at an increased risk of neonatal mortality **(Table 1).** Particular attention should be paid to the at-risk individuals: provide them with oxygen, artificial feeding, heat, or even adapt their vaccination protocol to increase their chances of survival. The following parameters can be monitored in the newborn dog and cat: APGAR score, blood lactate and glucose levels, birth weight, weight gain, and body temperature.

Care must be taken when weighing the newborns: always use the same scale for daily weighing, with high sensitivity (< ± 1 g) and with ranges between 50 and 500 g.

APGAR score at birth

The APGAR score should be evaluated within the first 10 minutes of birth, although values taken up to 8h after birth are also predictive. Each parameter must be scored on a scale of 0-2 and all scores added together (see chapter "Neonatal resuscitation" for "APGAR score calculation").

Scores < 7/10 are associated with 2 times and 7 times higher risk of neonatal death in puppies and kittens, respectively.

Table 1. Threshold values defining at-risk newborns.

Biomarker	At birth (< 20min)	At 24h	At 48h
APGAR score	< 7/10		
Blood lactate	< 5 mmol/L (45.05 mg/dL)		
Blood glucose	< 2.22 mmol/L (40 mg/dL)	< 5 mmol/L (90 mg/dL)	
Rectal temperature	< 32 °C/89.6 °F	< 34 °C/93.2 °F	< 34 °C/93.2 °F
Birth weight	Low birth weight		
Growth rate			< -4% of birth weight

Birth weight and growth rate 0-48h

Birth weight is the outcome of fetal growth, and growth rate after birth is correlated with passive immune transfer. Both are strongly predictive of neonatal mortality. Low-birth-weight puppies (the lightest 25%) have a three times higher risk of neonatal mortality, and puppies losing weight within the first 48h after birth (loss of more than 4% of birth weight in dogs), have eight times the risk.

Blood lactate levels at birth

Blood lactate is a biomarker of the level of acidosis and is proposed as an early predictor of mortality in puppies, mainly in cases of dystocia and following hypoxia. Blood lactate can be measured from a drop of blood obtained from the umbilical cord or the marginal ear vein using a portable device and single-use strips.

No threshold value is available to determine a higher risk of death in puppies or kittens, although results above 5-6 mmol/L (45.05-54.05 mg/dL) at 5-20 minutes after birth were associated with an increased risk of death in canine newborns.

As puppies and kittens are not able to regulate their body temperature during the first week of life, it is paramount to provide them with energy from the colostrum as soon as possible after birth.

Blood glucose within the first days

As newborns suckle their dam very frequently during the first days of life *(i.e.*, once per hour during the first 24h of life), their blood glucose is physiologically elevated. Thus, blood glucose is a good biomarker of newborn health. Blood glucose can be easily assessed in newborns from the umbilical cord or a marginal ear vein in both puppies and kittens using a portable device calibrated for dogs or cats. In puppies, values below 5 mmol/L (90 mg/dL) 24h after birth were associated with a four times higher risk of neonatal death, whereas in those with values below 2.22 mmol/L (40 mg/dL), mortality risk was multiplied by six because of hypoglycemia.

Body temperature within the first days

Body temperature of canine and feline newborns drops rapidly in the first hours after birth, followed by an increase to stabilize at about 36-37 °C/96.8-98.6 °F by 24h.

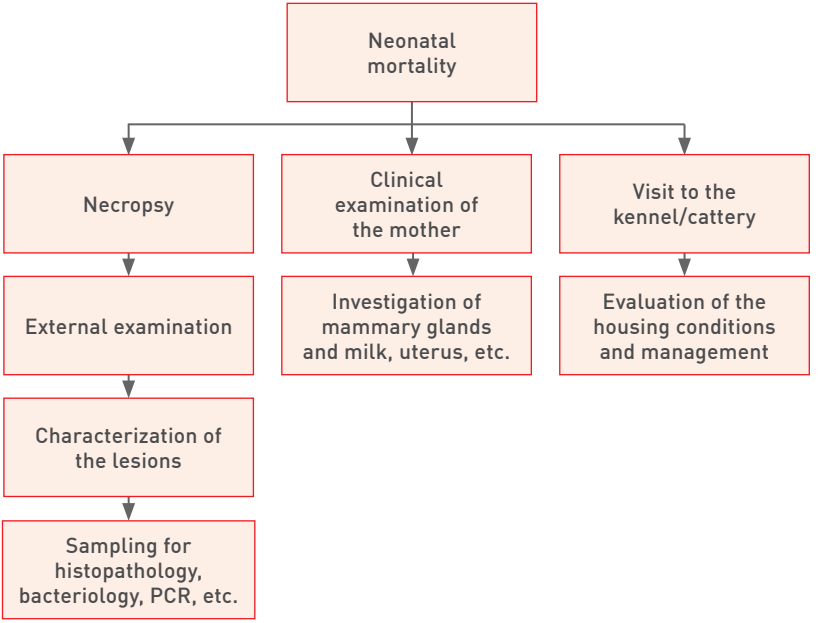
If there is a lack of colostrum intake, they may develop hypoglycemia and hypothermia leading to secondary bacterial infection. Thus, the body temperature should be monitored, particularly in low-birth-weight newborns or newborns suffering from hypoglycemia. A rectal temperature at or below 34 °C/93.2 °F is considered critical, and some extra heating, such as an incubator, should be provided to hypothermic individuals. To monitor the rectal temperature, a pediatric thermometer with a flexible tip and a range between 32 °C/89.6 °F and 42 °C/107.6 °F and accuracy of ± 0.1 °C/0.2 °F is recommended.

GUIDELINES IN THE EVENT OF MORTALITY

It is always a traumatizing experience for the puppy or kitten owner, as well as for the breeder, if a animal dies. It is also an important economic loss for the kennel or cattery. For all these reasons, but also to prevent mortality in littermates, a postmortem investigation aiming to define the cause of death should always be offered.

How to proceed in case of neonatal mortality?

In order to find the cause of neonatal loss, the investigation should be performed on three levels: neonatal, maternal, and environmental.



Highlights of postmortem examination

- Instruct the puppy or kitten owner to store the cadaver at + 4 °C/39.2 °F as soon as possible after death to avoid autolysis and putrefaction.
- Because postmortem examination can only be performed once, look for both macro and microscopic lesions and take as many samples as possible and store them for further analysis.
- Continue the organ sampling even though there are no obvious visible macroscopic lesions. Necropsy alone helps to determine the cause of death in only 22% of cases whereas, together with histopathology and microbiology, postmortem examination is conclusive in 90% of cases.
- Due to the high risk of bacterial infection in newborns, systematically perform bacteriology of the spleen or other internal organs in puppies and kittens under 3 weeks of age but only if the postmortem examination can be conducted in the first 24h after death **(Table 1).**

Equipment required to perform a necropsy in a puppy or kitten

- Adhesive tape
- Sterile scalpel
- Sterile scissors
- Sterile forceps
- Suture material
- Needles and syringes
- Sterile dry swabs
- Sterile swabs for bacterial culture
- Container with 10% buffered formalin
- Sterile dry tubes of different size
- Notebook
- Camera

Table 1. The steps in a postmortem examination.

Body storage	Store the cadaver at + 4 °C/39.2 °F as soon as possible until the necropsy, ideally in a lying position (lateral decubitus), with the limbs apart and the mouth open. Avoid placing the body in a plastic bag. Do not freeze the cadaver to avoid cellular damage, making histopathological examination impossible. A diagnostic necropsy can be performed only on a rapidly refrigerated body stored for a maximum of 2-3 days.
Clinical history	Collect information on the animal's history, such as its breed (breed predisposition), colostrum intake, vaccination and deworming history, and nutrition, but also medical history of the female during gestation, parturition, and lactation, along with any problems observed beforehand in the breeding kennel or cattery. Ask for the clinical signs presented before death of the puppy or kitten as well as its littermates or other animals living in the same household. Ask for the growth records of the animal. Examine the mother and littermates.
Necropsy	Prepare the necessary equipment. Start with the external examination searching for congenital abnormalities or signs of trauma. Perform pharyngeal, ocular (if eyelids are open), and rectal swabs. Tie out/down the cadaver. Incise the skin from the mandibular symphysis to the pubic symphysis. Open the thoracic and abdominal cavities and assess the organ position, shape, and color in situ. Look for any effusion or adhesions. Remove the viscera and reassess them. Open the skull and assess the brain tissue. Record the major findings.
Sample collection and analyses	Sample all organs with macroscopic lesions in a formalin container (1:10). Take 8x8 mm samples, if possible, at the junction between the lesion and the macroscopically healthy tissue. If no lesions are visible, systematically take histological samples of the heart, lung, liver, and kidney. Depending on the clinical hypothesis, take samples of organs (about 25-50 mm^2) suggested by the microbiological laboratory into a dry sterile tube, identify them, and freeze at -20 °C/-4 °F. In case of suspected parasitosis, stools may be taken from the terminal portion of the digestive tract.
Interpretation of results	Once all results are gathered, define the immediate cause of death (for example, acute hemorrhagic enterocolitis). Try to determine the underlying cause of death (for example, canine parvovirus) in order to prevent it in other animals from the household.

UP TO THE WEANING

NUTRITIONAL WEANING MANAGEMENT

At 3 to 4 weeks of age, nutritional needs begin to exceed what can be provided by milk alone, and the nutritional weaning phase should begin. The transition to solid foods should occur gradually.

Transitioning from milk to solid food

Commercial diets designed for weaning puppies and kittens are available. Dry products can be mixed with water to make a gruel (1:2 dry food to water) **(Figure 1).** Cow's milk should not be used to make the gruel because it contains high lactose concentrations and can cause diarrhea. Milk replacer can be used for the first days of transition, but it has a higher energy density, which can lead to excess weight gain negatively impacting the animal's metabolism; water is therefore preferred for kibble rehydration. Homemade weaning formulas should be avoided as these diets do not meet the specific nutrient requirements for proper growth and development.

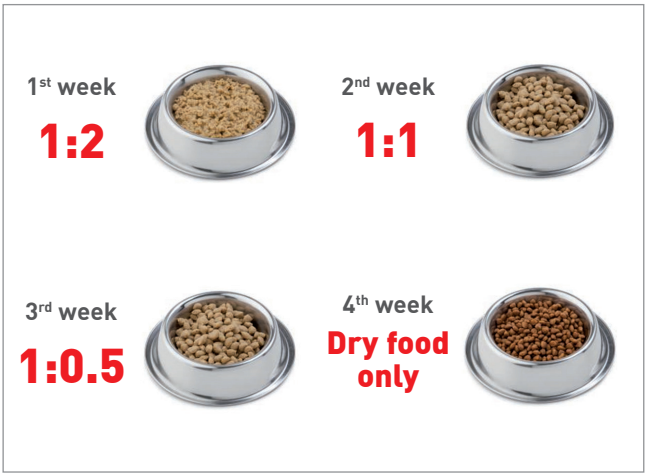


Figure 1. The weaning process for puppies should be as smooth as possible; the image shows the ratio of water to kibble to be used (by volume, not weight) to rehydrate dry food. During the first week of weaning, milk replacer can be used instead of water.

During the first week of weaning, milk will remain the major food source. Milk production will gradually decline as the puppy and kitten begin to eat solid food and are progressively separated from their mother. The deciduous teeth erupt around 21 to 35 days after birth. Thus, by 5 weeks of age, solid foods should be readily consumed so that by 6 to 8 weeks of age, weaning is complete. The typical requirements for puppies and kittens during this period range from 200 to 220 kcal metabolizable energy/kg body weight per day. Daily requirements should be divided into four meals minimum to avoid diarrhea. It has also been suggested that a probiotic will support the immune response to gastrointestinal pathogens and digestive stress during this time.

The caloric intake of the dam should be limited during the weaning period, providing she is in good condition. This helps to reduce milk production and minimize the risk of milk congestion and mastitis postweaning. From week 6 of lactation to weaning, the energy intake should be decreased to around 150% relative to maintenance needs (vs. 200 to 300% at weeks 2 to 5 of lactation). This can be reduced by another 25 to 50% after 1-2 weeks post-weaning, and then to 100% of maintenance requirements can be fed from 3 weeks and onwards post-weaning. The nutrient-dense diet that was fed during gestation and lactation should continue as the main diet for at least 3 weeks post-weaning to ensure adequate nutrient replenishment of the bitch and queen. Animals in poor body condition at breeding and whelping may require longer replenishment periods.

THE IMMUNITY GAP

All puppies and kittens are affected by the immunity gap, a critical period in the transition between the immunity passively transferred from the mother and the development of their own immunity following vaccination.

What is the role of maternally derived antibodies?

Maternally derived antibodies (MDA) are antibodies against pathogens which bitches and queens have been exposed to or vaccinated against, which are transferred to their offspring in the colostrum, *i.e.,* the milk secreted by the mammary gland in the first 2 days after parturition. In contrast to humans, cats and dogs are unable to transfer large amounts of MDA in utero due to the low permeability of the canine and feline placenta to immunoglobulins **(Figure 1).** Only 5-10% of MDA are transferred during pregnancy. Most MDA, mainly immunoglobulin G (IgG) antibodies, are transferred after birth, reaching the small intestine and being transported across the intestinal epithelium into the neonatal circulation. These antibodies can protect puppies and kittens in the initial weeks of life, but they also interfere with vaccination since high MDA titers can sequestrate the vaccine agents, preventing the onset of an active immune response against them.

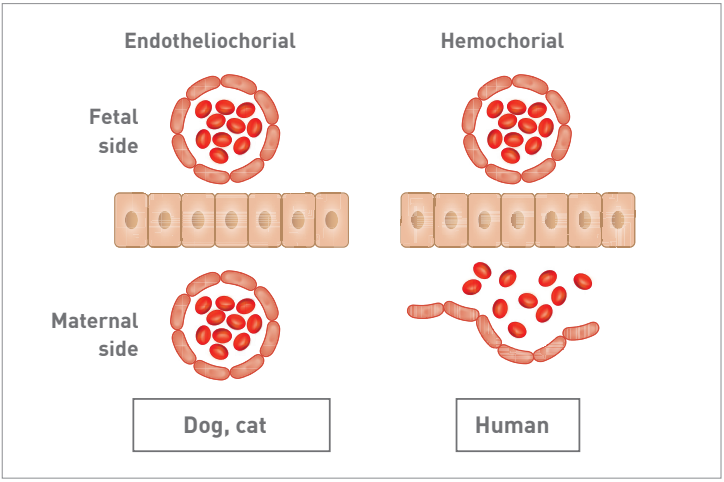


Figure 1. Placentation type across species.

What is the immunity gap and when does it occur?

MDA titers are not lifelong; they decrease over time mainly as a consequence of the growth of puppies and kittens and dilution of the initial antibody quantity in an increasing volume of blood. The half-life of these antibodies ranges from 8 to 10 days according to the species and breed. For instance, large-breed dogs that have higher growth rates have a shorter MDA half-life compared to puppies belonging to small breeds. In dogs and cats, MDAs generally persist for 8-12 weeks, but they may interfere with vaccination until 14-15 weeks of age.

The immunity gap can last from 2 to 5 weeks, but the period when it occurs is not predictable since it depends on several factors, including the antibody titers of the mother, the amount of colostrum consumed by the neonate, the growth rate of the animal, and the specific pathogens.

In contrast, puppies and kittens may be susceptible to infection with field pathogens some weeks before, so that during the decline phase of MDA there is a particular period in their early life, known as immunity gap or window of susceptibility, during which their MDA is still able to interfere with vaccination but not to prevent active infection with the field pathogens **(Figure 2).**

For instance, it is well known that parvoviruses are pathogens of domestic carnivores with a very long-lasting persistence of MDA, so that the immunity gap can occur later compared to other pathogens. For these viruses, hemagglutination inhibition (HI) MDA titers > 1:20 can prevent the development of the immune response, whereas protection against infection (and sometimes disease) is warranted by HI titers ≥ 1:80. Therefore, puppies and kittens with MDA titers between 1:20 and 1:80 might not seroconvert after parvovirus vaccination, but they are susceptible to infection with the field strains.

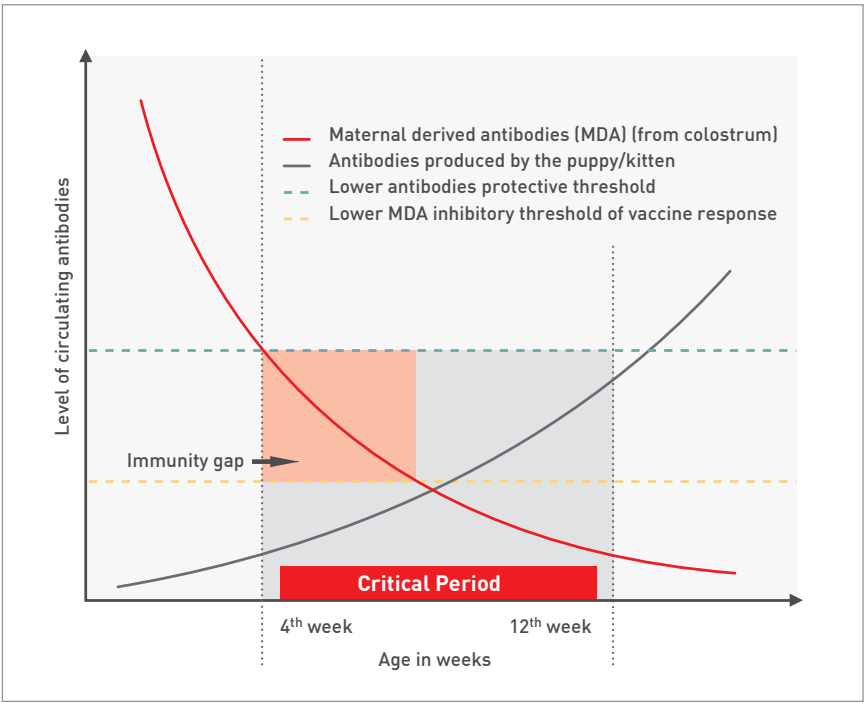


Figure 2. Immunity gap in puppies and kittens.

VACCINATION OF PUPPIES AND KITTENS

Vaccination is crucial in puppies and kittens in order to prevent the transmission of severe infectious diseases. There are different types of vaccines available on the market, and vaccination protocols should take into account several factors, including the age and lifestyle of the dogs and cats, as well as the epidemiological situation of the disease.

Core vaccines

These are vaccines that should be administered to all dogs and cats regardless of lifestyle or geographical area since they confer protection against infectious diseases that are particularly severe (often fatal) and widespread across the world. Core vaccines for dogs include those for the prevention of canine parvovirus infection, canine infectious hepatitis (caused by canine adenovirus type 1), and distemper, while feline core vaccines counter feline panleukopenia, infectious rhinotracheitis (caused by feline herpesvirus), and calicivirus infection.

Most core formulations are modified live virus (MLV) vaccines; they consist of viral strains adapted to in-vitro growth, which have lost their pathogenic potential but retain their immunogenic activity. MLV vaccines can replicate in the host, so that in the absence of interfering MDA levels, they do not need booster administrations.

However, some core vaccines (especially for cats) can be inactivated: they contain viruses that have been killed using chemical substances, are adjuvanted (the adjuvant triggers an inflammatory response, which is needed for the chemotaxis of leucocytes), and require booster vaccination. Few core vaccines are recombinant; they are prepared with a microorganism not specific to dogs or cats, such as the canarypox virus, which expresses the immunogenic protein(s) of the carnivore virus.

Non-core vaccines

These vaccines prevent infectious diseases that are not characterized by a severe clinical course or that are severe but do not have a worldwide relevance. Therefore, these vaccines are recommended in particular categories of animals or specific geographical areas.

The most important non-core vaccine is against rabies, an invariably fatal disease which is not present in all parts of the world. In countries where the disease is endemic, vaccination of dogs and cats against rabies is not only recommended, but sometimes mandatory. Rabies vaccines for pets are generally inactivated or recombinant.

In dogs, other non-core formulations include vaccines against leptospirosis (killed vaccines) and some agents of the canine infectious respiratory disease (CIRD), including canine parainfluenza, infectious tracheobronchitis (caused by canine adenovirus type 2), canine influenza, and *Bordetella bronchiseptica* infection. These are killed or live avirulent formulations, the latter being licensed for parenteral, intranasal, or oral administration. In pregnant bitches living in crowded environments (kennels, shelters), vaccination against canine herpesvirus with a subunit vaccine (prepared with a single viral glycoprotein) can be carried out to protect newborn puppies from systemic infection. Other non-core vaccines available for dogs (leishmaniosis, babesiosis, Lyme borreliosis) are registered for their first administration in puppies older than 6 months of age.

The most important non-core vaccines for cats are those against feline leukemia virus (inactivated, subunit, or recombinant formulations), *B. bronchiseptica,* and *Chlamydia felis* (killed or avirulent live). Other vaccines available for cats (feline immunodeficiency, feline infectious peritonitis) are usually not recommended due to unproven efficacy and/or interference with diagnostic assays.

Vaccination protocols for puppies and kittens

Vaccination of puppies **(Table 1)** and kittens **(Table 2)** should not begin before 6 weeks of age. Vaccines licensed for the first administration at 4 weeks could be used before the 6th week in particular epidemiological and environmental conditions *(e.g.,* in shelters, kennels, and catteries where there is an active pathogen circulation). The recommended primary course for feline and canine core vaccines includes at least three vaccine administrations in the first year **(Table 3),** at 2-4 week intervals, starting from 6-9 weeks of age and with the last dose given not before the 16th week, to allow MDA to decline below interfering levels. This protocol is then followed by revaccination after 6 months to 1 year (or, alternatively, at 6 months to 1 year of age) and booster vaccinations every 3 years.

More specific protocols are recommended for non-core vaccines according to the vaccine type and target species. Note that the vaccine against the canine herpesvirus-induced neonatal disease is administered to bitches soon before or after mating to prevent infection of newborn puppies following contact with contaminated vaginal secretions during birth.

Table 1. Main vaccines used in puppies.

	Vaccine type(s)	Route of administration	Notes
Core vaccines			
Canine parvovirus infection	MLV, recombinant	SC, IM	Types CPV-2, CPV-2b, rCPV-2c (recombinant)
Canine infectious hepatitis (canine adenovirus 1 infection)	MLV	SC, IM	CAdV-2 (related virus): protect against infectious tracheobronchitis and cross-protect against canine infectious hepatitis
Canine distemper	MLV, recombinant (canarypox vectored)	SC, IM	CDV strains Onderstepoort, Rockborn, Snyder Hill
Non-core vaccines			
Rabies	Killed, recombinant (canarypox vectored)	SC, IM	Recommended or mandatory in endemic areas
Canine leptospirosis	Killed	SC, IM	Serogroups prevalent in different geographic areas (mainly Icterohaemorrhagiae, Canicola, Australis, Grippothyphosa). Multivalent vaccines preferred
Canine parainfluenza, *B. bronchiseptica*	Killed, MLV	SC, IM IN or O	
Canine influenza	Killed	SC, IM	Influenza A virus subtypes H3N8, H2N3

CPV – canine parvovirus, r – recombinant, CAdV – canine adenovirus, CDV – canine distemper virus, SC – subcutaneous, IM – intramuscular, IN – intranasal, O – oral.

Table 2. Main vaccines used in kittens.

	Vaccine type(s)	Route of administration	Notes
Core vaccines			
Feline panleukopenia	MLV, killed	SC, IM	Killed vaccines not recommended
Feline infectious rhinotracheitis (feline herpesvirus infection)	MLV, killed	SC, IM	Killed vaccines not recommended
Feline calicivirus infection	MLV, killed	SC, IM	Killed vaccines not recommended
Non-core vaccines			
Feline leukemia	Killed, recombinant (canarypox vectored), protein subunit	SC, IM	
Rabies	Killed, recombinant (canarypox vectored)	SC, IM	Recommended or mandatory in endemic areas
Chlamydia felis	Killed Avirulent live	SC, IM	
B. bronchiseptica	MLV	IN	

SC – subcutaneous, IM – intramuscular, IN – intranasal.

Table 3. Primary course of vaccination for canine and feline core vaccines.*

Age at first administration	Subsequent schedule
6 weeks	9, 12, 16 weeks, then 6 months or 1 year or 10, 14, 18 weeks, then 6 months or 1 year
7 weeks	10, 13, 16 weeks, then 6 months or 1 year or 11, 15, 19 weeks, then 6 months or 1 year
8 weeks	11, 14, 17 weeks, then 6 months or 1 year or 12, 16 weeks, then 6 months or 1 year
9 weeks	12, 15, 18 weeks, then 6 months or 1 year or 13, 17 weeks, then 6 months or 1 year

*Adapted from WSAVA Vaccination Guidelines (https://wsava.org/global-guidelines/vaccination-guidelines/).

DEWORMING
PUPPIES AND KITTENS

Deworming, along with vaccination, is a crucial step to keep puppies and kittens healthy and to prevent the transmission of zoonotic helminths to humans. The choice of the anthelminthic treatment depends on a plethora of factors, including the parasite species, the host species, age, lifestyle, and drug registration in different countries.

Intestinal worms

For intestinal worms, fecal testing is essential to determine which species of worms may be present and to make the best use of anthelminthics and evaluate the efficacy of the treatment. Heartworm testing should be also performed on a regular basis for circulating antigens and microfilariae in the blood *(Dirofilaria immitis)* or live larvae from fresh feces *(Angiostrongylus vasorum).*

Puppies and kittens are commonly infected with roundworms, which are passed from mother to offspring while in uterus and through nursing. Therefore, early treatments are needed against these nematodes. Puppies and kittens should be treated starting from 2 weeks of age, then every 14 days up to 2 weeks after weaning. Monthly treatments are routinely administered up to six months of age, while at least 1-2 treatments per year are required in adults **(Figure 1).** Pregnant bitches may be treated during pregnancy to prevent transplacental and transmammary transmission of *Toxocara canis* larvae **(Figure 2)** to the puppies (see chapter "Deworming the bitch and queen").

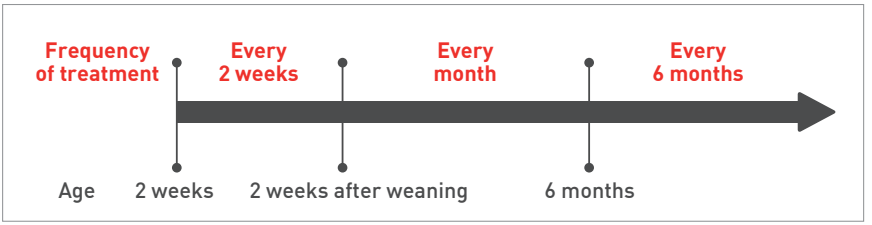


Figure 1. Anthelmintic treatments against roundworms and hookworms for dogs and cats. For puppies and kittens, the first administration is at 2 weeks, then every 2 weeks up to 2 weeks after weaning, then monthly up to 6 months of age, and twice per year for adults.

Treatments carried out against ascarids are also effective against hookworms *(Ancylostoma* spp. **(Figure 3),** *Uncinaria* spp.). Therefore, no additional treatments are required for deworming against these zoonotic nematodes.

Tapeworms usually cause subclinical infections in dogs and cats and do not represent a clinical issue for young animals. Periodic treatments are carried out to prevent zoonotic risk and it is not strictly necessary to treat young puppies and kittens. Dogs and cats going outdoors without supervision (thus potentially eating prey animals) or having access to raw meat or offal should be treated at least 4 times a year and up to monthly. Alternatively, they should be tested every 2-3 months by fecal examination. Treatment of *Dipylidium caninum* **(Figure 4)** in dogs and cats must be combined with appropriate flea control. Treatment with praziquantel could be required before transporting puppies and kittens to *Echinococcus* spp. non-endemic areas.

Worms of the circulatory and respiratory systems

Heartworm infection is prevented by the administration of macrocyclic lactone medications as soon as possible. Dogs and cats, regardless of their lifestyle, should be on year-round heartworm prevention in endemic areas. For *Dirofilaria immitis*, prophylactic larval treatment with macrocyclic lactones is advised at monthly intervals during mosquito season. Mosquito repellents should be also used to prevent infection. Heartworm prevention treatments containing praziquantel are also effective against cestodes.

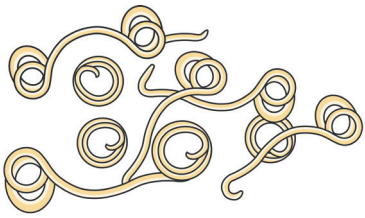


Figure 2. *Toxocara canis.*

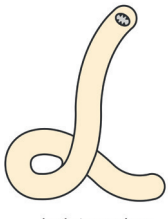


Figure 3. *Ancylostoma* spp.

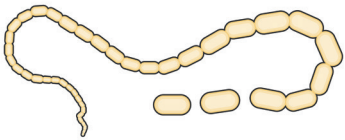


Figure 4. *Dipylidium caninum.*

SOCIALIZATION PERIOD: WHAT IS IT AND WHY IT IS IMPORTANT?

During the initial months of life, both dogs and cats experience a period of socialization, during which they learn very rapidly about their world. They learn what is safe, what is not safe, and how to communicate with their own species and with humans. This period starts at the breeder's, once their eyes have opened, and lasts into the first months of living with their new family.

Developmental socialization

During the socialization period, it is important that pets are exposed to the world they will encounter as adults in a positive context. Puppies and kittens should be exposed to novel stimuli in a way that creates a positive association **(Table 1).** They should never be forced to interact, but instead have the time and space to discover in their own time. Exploration should be associated with rewards such as attention, praise, play, or food. Negative experiences should be avoided, as puppies and kittens not only make positive associations very quickly during the socialization period, but negative ones also. For example, a single painful experience at the veterinarian during the first vaccination visit may cause a lifelong fear of the veterinary clinic. Therefore, care should be taken to carefully create experiences that help puppies and kittens to develop into confident pets **(Table 2).**

Table 1. Overview of the timing of the sensitive periods and developmental transitions during early life in dogs.

Neonatal (0-2 weeks)	Transitional (2-3 weeks)	Early socialization			Late socialization (12 weeks - 6 months)	Adolescence (6 months-1 year)
		3-5 weeks	5-8 weeks	8-12 weeks		
Immature brain Vision and hearing under-developed	Immature brain Opening of eyes and ears	Brain maturation and myelinisation		Myelinated nerves Adult EEG waves		
Poor locomotor skills	Increased locomotor activity	Sensitive to novelty in environment SHRP*	Sensitive to novelty in environment Weaning		Reinforce-ment of socialization	
Care seeking behavior		Exploratory behavior	Increasing fear of novelty Decreasing exploration Peak sensitivity to human contact			
		Play with mother and littermates		Play with littermates		
					Sexual maturation	Sexual maturity

**SHRP: stress hypo-responsive period; period during which adrenocorticotropic hormone (ACTH) and glucocorticoid (GC) release in response to a stressor is strongly attenuated and modulated under the influence of maternal care; to protect the developing brain from the potential negative impact of high levels of GC.*

From Dietz L, *et al.* The importance of early life experiences for the development of behavioural disorders in domestic dogs. *Behaviour* 2018.

Kitten and puppy classes

Pets learn very quickly during the socialization period (2-8 weeks in kittens **(Figure 1);** 3-12 weeks in puppies). Pets that miss positive experiences with a range of stimuli during the socialization period often show fear-related undesirable behaviors later on. However, if the socialization period is well utilized, a solid foundation can often be laid to prevent many fear-related behaviors as adults. Temperament also plays an important role in the development of desirable or undesirable behaviors, and cats and dogs can have positive learning experiences at any age.

For puppies, your veterinary practice can offer socialization classes or you may recommend other pet professionals. If properly conducted, these classes offer a safe environment for puppies to interact with other dogs and learn about their

Table 2. Learning experiences leading to desired skill sets for dogs and cats.

	Kittens	Puppies
Social – intraspecies	• Appropriate play and social behavior with other cats (for cats that are, during their lifetime, expected to interact with other cats)	• Appropriate play and social behavior with dogs of other breeds, sizes, and ages
Social – interspecies	• Early exposure to humans (or other species) • Friendly experiences with humans of different ages and appearance	
Environment	**Positive experiences of:** • all household items they are expected to be comfortable with as adults, *e.g.,* vacuum cleaner, washing machine; • noises that may otherwise cause fear response, *e.g.,* thunderstorms, fireworks, etc.	
	• For outdoor cats: relevant outdoor stimuli	• Dogs: all outdoor stimuli: cars, public transportation, different surfaces they may encounter on walks, elevators, etc.
Manners	• Appropriate play with humans (no claws or teeth) • Scratching only on appropriate surfaces *(e.g.,* scratching post)	• Appropriate play with humans (no jumping or teeth) • Chewing only on items dedicated for this purpose
Grooming/ handling/ veterinary visit	• Becoming comfortable with carrier/transport crate • Becoming comfortable with nail clipping, taking pills, getting their ears checked • Getting used to mouth handling and tooth brushing • Getting used to car rides • Becoming comfortable with being groomed, with being handled, held for a few seconds • Getting to know the veterinary clinic as a place full of positive experiences	
Elimination behavior	• Learning to use the litter box	• Learning to eliminate outside the house/in designated areas
Emotional regulation	• Settling down and relaxing after an exciting event or in the presence of an exciting stimulus • Self-control around an arousing stimulus • Dealing with frustration if something desired is not available	

environment. Puppy socialization classes should not only offer play with other dogs, but also expose dogs to a variety of different stimuli and educate owners about the prevention of the most common undesirable behaviors.

Puppies and kittens do not need to be fully vaccinated to start their socialization journey. Most puppy classes will accept dogs 7 days after their first vaccination has been administered. Of course, puppies should be kept up to date with their vaccinations and they should not be exposed to high-risk situations, such as interacting with dogs that have a high likelihood of being unvaccinated or sick. Behavior problems are the most common reason for owners to relinquish their pet to a shelter and therefore the number one cause of death for dogs under three years of age. The benefits of proper socialization far outweigh the risks of infection if simple precautionary measures are taken.

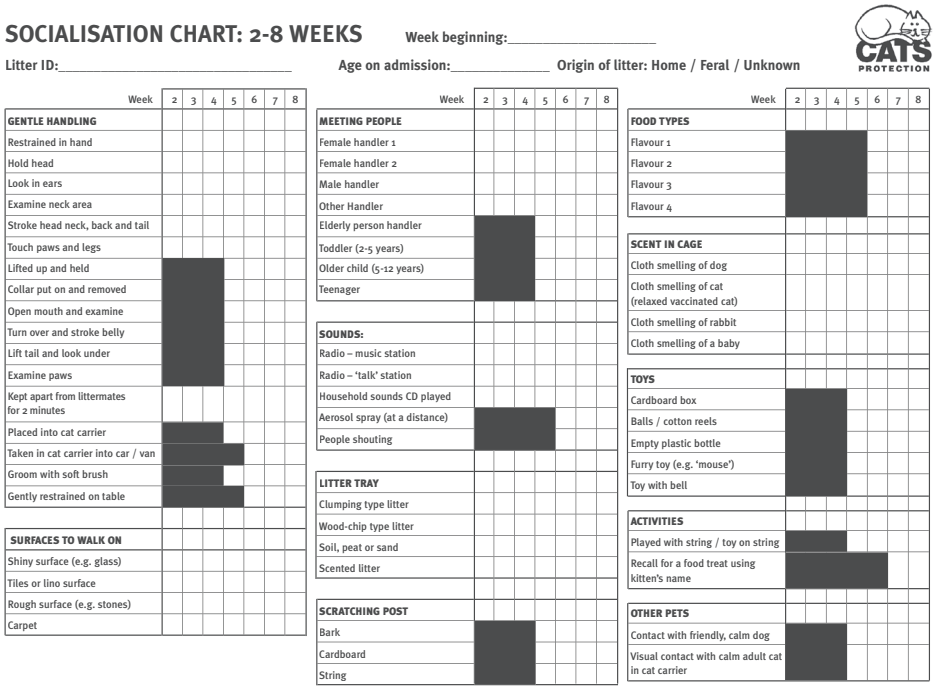


Figure 1. Example of socialization checklist for kittens from Cats Protection charity.

EDUCATION: HOW DO PETS LEARN?

Puppies and kittens are not born with the skills and experiences needed to adjust to our human world. Particularly during the first months of their life, they will need to be guided to learn how they should behave. Veterinary staff should provide advice to educate pet owners, so that they, in turn, can foster a positive relationship with their pet.

Education tips

- **Learning happens all the time.** Each experience allows pets to learn more about their world. Therefore, consistency is key for helping a pet make predictions. If the same experience, *e.g.*, putting their teeth on human skin during play, is once rewarded with more play and once punished by shouting at them, a pet will not understand what is expected of them. Furthermore, they won't be able to anticipate human reactions and therefore may feel stressed in the presence of humans.

Appropriate diet and sleep will support puppies and kittens in their cognitive development and memory consolidation.

- **Pets learn by association.** They can associate certain cues, such as the smell of the veterinary clinic, with an uncomfortable experience or with a pleasant one, depending on which experience is created for them. They also learn to associate their own actions or behaviors with positive or negative consequences.

- **Only behaviors that have positive consequences persist.** Pets do not engage in behaviors that "don't pay off," as this would be a waste of energy. Some behaviors are intrinsically valuable, such as emptying their bladder or chasing another animal. Other behaviors only have value if they are rewarded by someone else, such as begging at the table. If these behaviors are not rewarded anymore, they will disappear. But owners should be aware that before a pet gives up a behavior, they might try a little bit harder to be sure the behavior doesn't pay off.

- **"We are what we practice."** The more a pet practices behaviors appreciated by their owners ("desirable behaviors") and experiences positive consequences, the more they will exhibit them. The more a pet engages in undesirable behaviors with success, the more these behaviors will emerge.

- **Make the environment work for, not against you.** Pet owners can modify their pet's environment in a way that discourages undesirable behaviors and encourages desirable ones. The cat scratches on their owner's favorite couch? Access to the couch could be removed and instead a suitable scratching area be placed at the same spot. The dog runs to the fence and barks at the mailman? The dog could be left inside with a long-lasting chew toy until the mail has been delivered.

- **A pet's world is full of "reward opportunities":** their owner's attention, their daily food allowance, games, etc. These should be used to show a pet which behaviors are desirable in the human world and which are not **(Figure 1).**

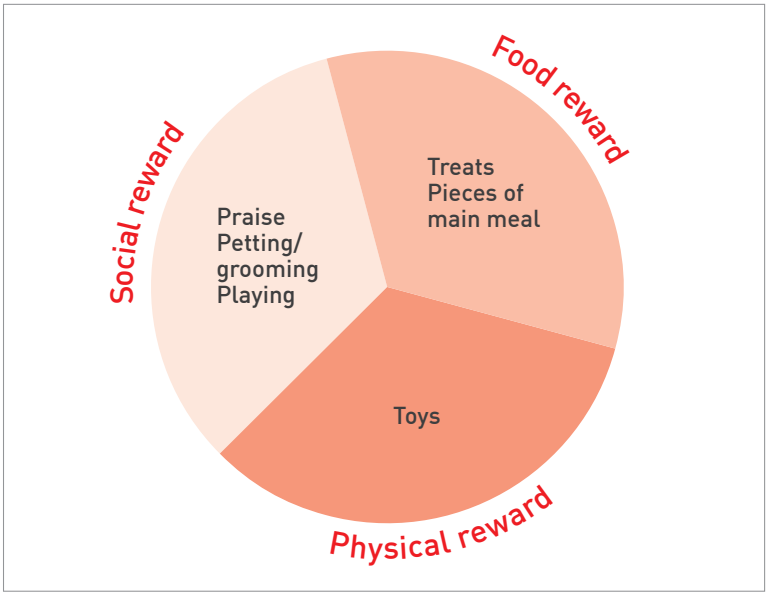


Figure 1. Example of rewards - to be adjusted to individual preference and health condition.

The use of aversives is not recommended. Why is that?

- For punishment to be effective, it needs to happen every time an undesirable behavior occurs, be associated only with the undesirable behavior, and be strong enough to interrupt the undesirable behavior immediately and for a prolonged period. In the real world, it is very difficult to fulfill all three conditions. Punishment is often the result of human frustration after other training attempts have failed. In this case, it is even less likely that the criteria for effective punishment are met.

- Even if punishment is effective in teaching a pet that an undesirable behavior is dangerous, it does not teach a pet which behavior is desired, nor does punishment address the underlying emotional state that might have triggered a certain behavior. For example, a dog that barks at another dog in fear might learn that barking at dogs is dangerous as he then receives a yank on the leash. However, the dog does not receive any guidance on how else to behave in this, for him, emotionally charged situation nor does his owner help him feel more comfortable around other dogs. A better approach to undesirable behavior is to address the underlying emotional state that triggers the behavior and to train an alternative, more desired behavior.

- Unpredictable punishment is particularly stressful for pets. Pets that have experienced unpredictable punishment may be less likely to interact at all with their environment out of fear of making a mistake and being punished. They may also resort to aggression to solve the problem, or they may even show "learned helplessness," *i.e.,* learn that they cannot control their environment at all and therefore stop trying to do so even in situations where they can.

What about the social behavior of dogs and cats?

- Dogs and cats have co-evolved with humans and can form close social bonds with us. Dogs in particular are able to cooperate with humans in complex tasks, such as herding or hunting, which require a high level of inter-species communication. All pets need human guidance and kind leadership to navigate a world that is tailored to meet human, not canine or feline, needs. This includes rewarding pets for desirable behaviors with attention, food, or play and providing an environment that meets their needs, increasing the likelihood of desirable behaviors and reducing the likelihood of undesired behaviors.

- Particularly for dogs, an outdated perception of dominance theory – with the idea that dogs strive to obtain a higher rank and need to be "dominated" – unfortunately still exists and is used by some trainers as justification for punishment-based training methods. The vast majority of undesirable behaviors are related to fear, poor inhibitory control, or low frustration tolerance and can be modified through the application of the principles of learning listed previously.

Rewarding pets for desirable behaviors with attention, food, or play and providing an environment that meets their needs will increase the likelihood of desirable behaviors.

HOUSE TRAINING: HOW TO ENCOURAGE ELIMINATION IN THE DESIRED PLACE?

Both kittens and puppies need to learn about the best place to urinate and defecate in a human world. Setting the environment up in a way that the most desirable location from a human perspective is also the most attractive area for the feline or canine is critical, as elimination itself, *i.e.,* relieving the pressure of a full bladder, is intrinsically rewarding.

If a pet eliminates in a spot that is undesirable from a human viewpoint, punishment of the behavior should be avoided. Even if "caught in the act," it is sufficient to pick up the pet and place it into the area where elimination is desired *(i.e.,* outside for dogs or in the litter box for cats). Otherwise, pets might associate elimination behavior itself with punishment and therefore might avoid eliminating in front of their owners. This will pose a problem particularly for dogs if they refuse to eliminate during walks.

Pets like to eliminate in spots that soak up urine, such as litter boxes and grass, but also rugs, clothes, or plant pots for cats. They usually try to avoid elimination in their eating or sleeping area and may choose a calm spot slightly away from everyday noise and disturbance.

Kitten early litter box training

For kittens, it is usually sufficient to provide a suitable litter box and to restrict access to other attractive alternatives such as plant pots. Kittens should be closely observed over the first few days in a new home and as soon as the kitten shows signs of

searching for a suitable space to eliminate (sniffing the ground, scratching), their attention should be drawn to the litter box, or they should be gently placed in the litter box if needed. Any elimination in the litter box should be rewarded with attention or food (without disturbing the elimination process).

Litter box management for cats:

- Number of boxes: 1 more box than cats in the household, *i.e.*, 2 boxes for one cat.
- Placement: each box should be placed in a different location to offer the cat a choice. The location should not have a lot of traffic or noise (consider household items such as washing machines, etc.) and should be easy to access.
- Size: litter boxes need to be sufficiently sized, at least 1.5 times the length of the cat.
- Litter: cats may have individual preferences for the type of litter. In principle, a non-scented litter, with fine granules that do not hurt cats' sensitive paws, is a good starting point.
- Cleaning of litter boxes: they should be scooped twice daily and washed with a mild detergent once a week. It is better to use less litter (a depth of 4-5 cm should be sufficient), but then change the litter weekly rather than use more litter without changing it regularly.

Puppy early house training

For puppies, a few simple rules help to ensure early house training success:

- The puppy should have the opportunity to eliminate outside frequently during the day. Initially, they should be taken out every two hours when someone is at home and at least after every feeding, after every nap, and immediately after they are allowed out of their crate/confined area.

- When outside, the puppy should be kept on a leash until elimination has occurred. This way, the puppy learns that elimination is the pre-requisite for being allowed off the leash and having fun. If the puppy has a preferred spot for elimination, this is a good place to start the outside time. Elimination behavior should be rewarded with attention and praise (without interrupting the elimination) and a treat afterwards.
- In the house, puppies need to always be supervised until they have learned to eliminate outside. The puppy should be carefully observed for signs of needing to urinate (getting restless, sniffing the floor) and be taken out before elimination occurs. To ensure close supervision, the puppy should always be in the same room as their owner. If this is not possible, or if the puppy is left alone, they should be confined to a small area in the house. This could be a crate or a designated safe space in which the puppy is comfortable.
- Puppies' capacity to hold their urine depends on their size and age and will change over time. As a rule of thumb, a 3-month-old puppy can hold urine for up to 4 hours and a 4-month-old puppy up to 5 hours. An older dog should have the opportunity to eliminate every 6 hours.

For both dogs and cats, elimination in the house outside the dedicated area is a common reason for rupturing the human-animal bond. Owners should be encouraged to discuss any problems related to house training or usage of the litter box with their veterinarian early on to identify solutions.

WEANING DIARRHEA

Soft stools are more common in puppies and kittens than in adults for various reasons and are not necessarily considered diarrhea.

The use of a puppy-specific fecal score is therefore beneficial to keep track of the puppy's health and well-being (see "Fecal scoring system" in the Appendix section). The intestinal barrier and the immune system of the puppy and kitten are still developing. The stress of weaning can lead to an inadequate nutrient and energy intake resulting in reduced body weight or inadequate growth, reduced nutrient absorption, and further impairment of the immune system subsequently. Stress also affects the immune system directly. Potential pathogens such as viruses, bacteria, and parasites are often present in young animals, but with a challenged immune system, young animals are more susceptible. This is especially true if the puppies and kittens live in a busy environment with other dogs and cats who might not be regularly vaccinated or dewormed. This predisposes puppies and kittens to diarrhea during the weaning period **(Figure 1)**.

When puppies and kittens are 6-8 weeks of age, diarrhea occurs in up to 1 in 4 animals because:

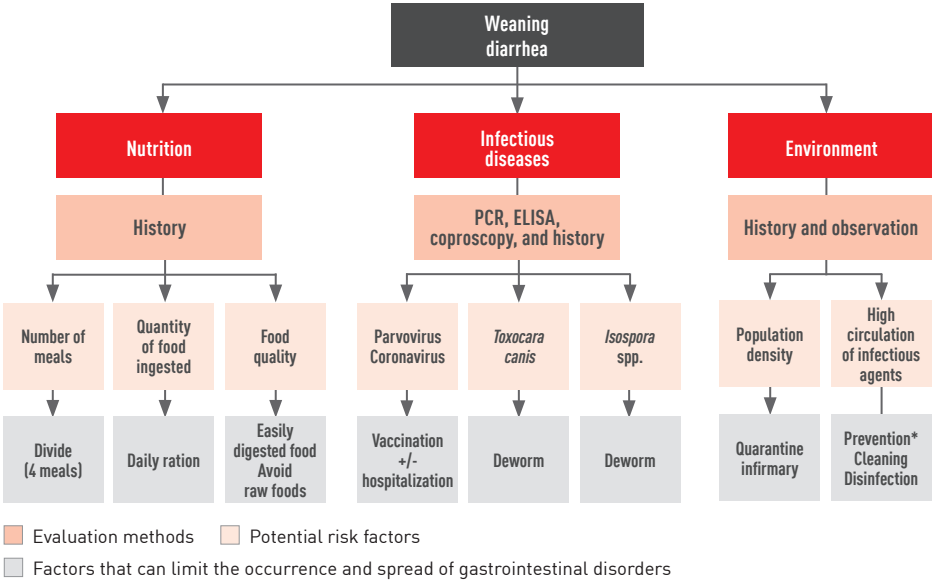
- Maternal antibodies provided by the mother's colostrum decline in the puppy's and kitten's bodies while their own immune system and its response to vaccination (if already carried out) is not fully protective against pathogens.
- Changing from a diet mainly composed of the mother's milk to a solid diet requires the development of enzymes and absorptive cells in the gastro-intestinal tract.
- The intestinal microbiota composition is still establishing itself and can easily be disrupted if not slowly introduced to a new diet. This disruption can cause diarrhea.

While the puppy's and kitten's age, immune status, breed, and genetic variation at weaning cannot always be influenced, good management of the environmental hygiene, population density, temperature and humidity, and any stressful events *(e.g.,* separation from the mother and siblings) can reduce the risk of weaning diarrhea and its severity. In addition, the dietary regime is very important to prevent digestive upsets.

- The puppy's and kitten's diet should be highly digestible, of high caloric density, complete and balanced providing all required nutrients, and of the highest hygienic quality.

- If the mother is fed a high-quality reproduction-type food, this food can also be used to feed the puppies and kittens.
- Mixing small quantities of warm water with the food will make the food more attractive and palatable to the puppies.
- Start offering the puppy and kitten a solid diet between 3-4 weeks of age. Offer a fresh bowl of food several times per day to ensure good hygiene and high palatability.
- To avoid rapid diet changes, ensure that the puppies and kittens eat already sufficient amounts of their new diet before being weaned from their mother.
- When changing from one diet to another, especially if changing from wet to dry food or vice versa, allow for a slow transition period of ideally 7 days.

Figure 1. Evaluation and management of weaning diarrhea in puppies.



**Cleaning should be systematic, with the puppy area cleaned first and the infected area cleaned last each time.*

From Grellet A. Weaning diarrhea in puppies. *Vet Focus* 2021.

RESPIRATORY DISORDERS IN UNWEANED KITTENS

Pre-weaning mortality rates in kittens are disturbingly high at 15.7%. Of these, 8.5% are due to stillbirth, with a further 7.9% of kittens dying within 60 days because of a greater likelihood of them developing illness due to infectious disease. The respiratory tract can be affected by a range of conditions which, broadly speaking, can be divided into congenital, traumatic, or infectious etiologies.

Congenital respiratory disorders

Congenital abnormalities have been reported to occur in 0.1-7% of kittens. These can be due to genetic abnormalities, exposure to teratogens, or arise spontaneously. Despite these conditions being present from birth, many do not manifest until the kitten is a few weeks or months old.

Cleft palate

Incomplete closure of the palate can be an inherited trait or can result from exposure to teratogens such as hypervitaminosis A or the administration of corticosteroids, metronidazole, or griseofulvin to the queen during pregnancy. Defects of the soft palate can lead to both upper and lower respiratory tract infections. Affected kittens often demonstrate poor growth, nasal discharge, and/or aspiration pneumonia. The deformity may be evident on examination of the oral cavity. Treatment of secondary infections and surgical closure of the defect can be curative (see chapter "Cleft palate and its surgical correction").

Diaphragmatic hernia

Both peritoneopericardial diaphragmatic hernia and peritoneopleural diaphragmatic hernias can be seen in young kittens. Peritoneopericardial hernia is the more common form in young kittens and is typically developmental in origin, especially in long-haired breeds such as the Maine Coon and Persian, where a breed predisposition is recognized. Peritoneopleural defects can be either traumatic or congenital. Clinical signs are rarely reported in very young kittens, and diagnosis is often made later in life. Treatment is surgical repair, but it should be noted that in some cases concomitant liver disease may be present as an increased incidence of ductal plate abnormalities has been reported in cats with congenital central diaphragmatic hernia or peritoneopericardial diaphragmatic hernia.

Sternal malformation

Flat chested syndrome is characterized by dorsoventral flattening of the rib cage. Although uncommon, there appears to be an increased incidence in Burmese, Bengals, and Oriental cat breeds. Affected kittens have a deformed ribcage beginning cranially around the forelimbs, with a sharp angulation at the costochondral junction causing marked dorsoventral flattening of the rib cage **(Figure 1).** The severity of the condition is highly variable, and mild cases may not demonstrate any clinical signs. With growth, the abnormality can become less evident and in these cases the prognosis is very good. Severely affected kittens may demonstrate weight loss, decreased suckling, failure to gain weight, and/or increased respiratory rate and effort. In such cases the prognosis is guarded.

Pectus excavatum is characterized by a dorsal deviation of the caudal sternebrae resulting in a loss of thoracic volume and potential respiratory compromise. The incidence in kittens is unknown, although it has been suggested that this anomaly may occur more frequently in Bengal and Burmese cats. Pectus excavatum has been positively correlated with flat-chested syndrome. Affected kittens are often reported to be tachypneic and have been reported to demonstrate antibiotic responsive episodes of dyspnea, suggestive of secondary bacterial pneumonia.

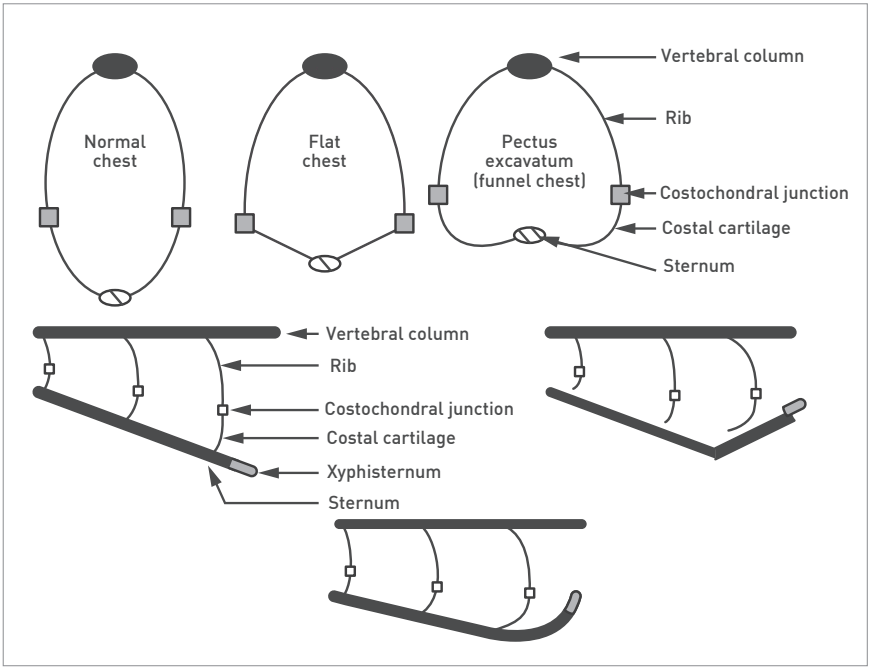


Figure 1. Forms of sternal malformation reported in kittens.

Treatment with the surgical placement of a sternal splint for a period of 4 weeks, in 10-15-week-old kittens has been associated with a good medium-term outcomes.

For exhaustivity, we can mention congenital lobar emphysema and both congenital and secondary megaesophagus as rare conditions in kittens.

Traumatic respiratory disease

Trauma is recognized as a significant cause of neonatal injury and death. The majority of documented cases involve trauma at the time of birth, often associated with hypoxia, and a very short survival time of only minutes to hours. Trauma can lead to issues such as diaphragmatic hernia or rib fractures.

Infectious respiratory disease

Common viruses associated with disease in kittens include Feline Herpesvirus (FHV), Feline calicivirus (FCV), Feline coronavirus (FCoV), and Feline panleukopenia virus (FPV). While FCoV and FPV are the most common causes of mortality in weaned kittens, FHV is the most common infectious cause of mortality in neonatal (2-14 days) kittens. In addition, *Bordetella bronchiseptica* or *Chlamydia felis* infection may be involved in respiratory disease. In some cases, other organisms may also be involved, including FCoV, reovirus, mixed bacteria, *Pasteurella multocida,* and *Mycoplasma* spp. Environmental factors, such as poor ventilation, high humidity, and over-crowding may exacerbate the problem.

The infectious agents associated with cat flu are typically transmitted by aerosol and/or direct contact with the conjunctiva or oral/nasal membranes. Herpes reactivation occurs in up to 40% of carrier cats when lactating. With reactivation there is often a lag phase of 4-11 days prior to viral shedding. Kittens who have adequate colostrum intake have some resistance, but MDA to FHV have been shown to wane early (within 2 weeks in some individuals), leaving kittens at risk early in life.

FCV infection is less common in pre-weaning kittens, although carrier queens may start to shed virus, typically the MDA typically lasts longer, with some studies demonstrating high levels of MDA against FCV until 10-14 weeks. The most consistent feature of FCV infection is oral ulceration.

Diagnosis

A presumptive diagnosis is usually made on the presence of typical clinical signs and a history of possible exposure to causal organisms.

Nasal or oropharyngeal swabs can be taken for isolation and culture, or PCR (in the case of FHV and *C. felis).*

Treatment of viral disease in kittens

The majority of viruses have no specific treatment and are often very difficult to manage. The anti-viral medication Famciclovir (40-90 mg/kg PO q8h) is the most potent and safe antiviral drug for FHV. It has been reported to be well tolerated if administered orally to kittens.

Both recombinant feline interferon – and human recombinant interferon – have been useful in other viral infections, but controlled clinical trials are lacking.

In infected kittens, good nursing care is the mainstay of treatment.

Non-specific treatment

- **Fluid therapy**

Kittens do not develop the ability to concentrate their urine until around 10 weeks of age. Kittens suffering from respiratory infections have decreased fluid intake and are prone to the development of hypovolemia. Unfortunately, this can be hard to assess as the skin contains more water and therefore skin tenting does not develop until the kitten is markedly dehydrated. Furthermore, the sympathetic nervous system is not fully mature until approximately 8 weeks of age and therefore young kittens cannot respond to hypovolemia in the same way as an adult (the heart rate will not increase).

The volume of fluid required to rehydrate is higher than that required for an adult. It is advised that the daily fluid requirement for a young kitten is 80-100 mL/kg/day with further adjustments added for ongoing losses. If intravenous (IV) access is problematic, intraosseous (IO) cannulation can be effective.

- **Nutrition**

Kittens that are unwell do not suckle, and inadequate nutritional intake can lead to hypoglycemia. This can occur rapidly as kittens do not have mature hepatic function and rapidly deplete their glycogen stores. Hypoglycemic kittens will become weak, lethargic, and can become anorectic and hypothermic. If a kitten has developed hypothermia, this should be addressed prior to providing nutrition *per os* as ileus or delayed GI motility are frequently encountered in hypothermic kittens, and therefore there is a high risk of regurgitation and aspiration pneumonia (the gag reflex is not present until around 10 days of age).

In a critically ill neonate (*i.e.,* hypothermic or dehydrated), a bolus infusion of 12.5% dextrose IV or IO (0.1 to 0.2 mL/100 g or more) may be required. This can be followed by a constant-rate infusion of 1.25% to 5% dextrose in a balanced electrolyte solution to prevent rebound hypoglycemia.

In a young kitten that is hypoglycemic, a stomach tube can easily be placed. With the kitten in sternal recumbency and the head elevated, a lubricated, soft French gauge 5-8 tube (premeasured from the nose to the last rib) can gently be passed down the left side of the mouth into the esophagus. This can then be used to periodically administer 5% to 10% dextrose orally at 0.25 to 0.50 mL/100 g body weight until the kitten is stronger; oral administration is then continued until the kitten is normoglycemic. The tube should be occluded prior to withdrawal to ensure the stomach content isn't aspirated.

If oral feeding is tolerated, meal sizes should be limited to about 4-5 mL/100 g body weight, as this is the maximum stomach capacity for a kitten.

- **Antibiotics**

Secondary bacterial infections are common in kittens and therefore antibiotics may be indicated. If secondary infection is suspected, broad-spectrum antibiotic cover with good penetration of the affected tissue is recommended (see below).

Bacterial respiratory infection in kittens

While bacterial infections may be secondary to viral infection, some will occur as a primary cause. Bacteria typically originate from the queen's birth canal [beta hemolytic *Streptococcus* spp. (*Strep*. G infection)], gastrointestinal tract *(E. coli, Salmonella* spp.*, Campylobacter* spp.*,* many normal enteric bacteria), or the respiratory tract *(Bordetella* spp.*, Pasteurella* spp.*, Mycoplasma* spp.). Clinical signs vary depending on the site and type of infection, but can include diarrhea, coughing, dyspnea, polyarthritis, omphalophlebitis, or dermatitis, as well as less specific signs. Kittens are particularly susceptible to the development of bacterial pneumonia as the gag reflex is not present until 10 days of age. Therefore, aspiration is not uncommon during the pre-weaning period.

Treatment of bacterial infections

Hydration, hypothermia, and the provision of adequate nutrition should be managed in the same way as for viral infections.

Antibiotics

Antibiotics should ideally be selected according to culture and sensitivity testing. However, it is often not possible to wait for laboratory results as neonates can decompensate rapidly. Therefore, in most situations antibiotics are selected empirically. Penicillins are often the first choice, as they are generally less toxic than most other antibiotics. However, if these are administered *per os* they can alter the gastrointestinal flora and cause diarrhea. In general, the parenteral administration of antibiotics is preferred because oral medications may not be absorbed efficiently.

Parasitic respiratory infections

Feline lungworms such as *Aelurostrongylus abstrusus* and *Troglostrongylus brevior* are typically associated with exposure to mollusks. However, it has been recognized that *Troglostrongylus brevior* infection can be present in very young kittens, leading to severe respiratory distress and even death. Investigations into the mode of infection have suggested that transmammary transmission of this parasite can occur. Although several treatments, including emodepside, eprinomectin, milbemycin oxime, and moxidectin, have been reported in occasional cases, there are no large-scale studies assessing effectiveness or safety. Therefore, current recommendations are to avoid outdoor access and to ensure the queen is treated with an appropriate anti-parasiticide prior to pregnancy.

The respiratory tract can be affected by a range of conditions which, broadly speaking, can be divided into congenital, traumatic, or infectious etiologies.

CANINE INFECTIOUS RESPIRATORY DISEASE COMPLEX

Canine infectious respiratory disease complex (CIRDC), commonly referred to as "kennel cough," is a highly contagious, multifactorial condition and is a real challenge in breeding facilities.

Etiology

Multiple bacterial and viral pathogens are implicated in CIRDC. The most common pathogens are canine parainfluenza virus (CPIV), canine adenovirus type 2 (CAV-2), and *Bordetella bronchiseptica* but other pathogens have been described over the last two decades and their prevalence may be underestimated **(Table 1).**

The pathogens associated with CIRDC are transmitted by oronasal exposure through contact with contaminated respiratory secretions. CHV-1 is also transmitted through genital secretions and transplacentally.

The incubation period is usually 2-3 days but can be up to 5 weeks (CDV). Disease management in breeding facilities is complicated by a preclinical shedding period and a prolonged period of shedding some of the pathogens.

Table 1. Pathogens associated with CIRDC.

Viral pathogens	Bacterial pathogens
Canine parainfluenza virus	*Bordetella bronchiseptica*
Canine adenovirus 2	*Mycoplasma cynos*
Canine herpesvirus 1	*Streptococcus equi* subspp. *zooepidermicus*
Canine distemper virus	*Pasteurella* spp. (secondary infections)
Canine respiratory coronavirus	*Pseudomonas* spp. (secondary infections)
Canine influenza virus	
Canine pneumovirus	

Clinical signs

Clinical signs are usually mild and self-limiting and can include coughing, sneezing, and nasal and ocular discharges but in young puppies more serious disease may be seen with fever, depression, conjunctivitis, and anorexia. Secondary bacterial pathogens may cause a more severe disease in some dogs.

Diagnosis

A clinical diagnosis can be made on a history of exposure to other dogs and by physical examination. Tracheal sensitivity is frequent, and a cough can often be elicited by tracheal palpation.

Diagnostic testing is indicated in a disease outbreak situation and in dogs presenting severe clinical signs or not responding to supportive care, with culture for bacterial pathogens and PCR for viral detection. However, most agents can also be isolated by PCR from healthy animals, so a positive result does not prove a causative relationship.

Treatment

Treatment for CIRDC is symptomatic and supportive. The use of antibiotics is usually unnecessary for the mild form but is often indicated in breeding facilities to limit the outbreak. Oral doxycycline is a relatively good empirical choice if *Bordetella* or *Mycoplasma* infection is suspected but tetracyclines as a class can retard fetal skeletal development and cause discoloration of the deciduous teeth. However, evidence from the human literature suggests that doxycycline is less likely to cause these abnormalities than other tetracyclines. In young puppies and the lactating bitch, aerosol therapy with nebulized gentamycin diluted in saline is a good option to avoid the use of doxycycline in the first instance for mild cases **(Figure 1).** Additional supportive care includes consistent monitoring of clinical signs and weight gain and to maintain appropriate levels of nutrition and hydration.

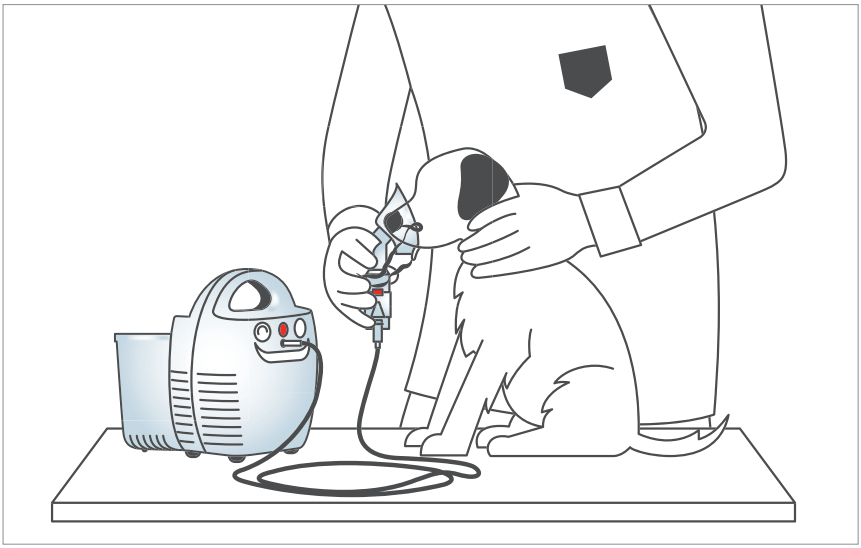


Figure 1. Aerosol therapy with nebulized gentamycin diluted in saline is a treatment option of CIRDC in young puppies and lactating bitches.

Prevention

Because of the diversity of pathogens involved in CIRDC, vaccination can only provide partial protection. Intranasal vaccines with a modified live virus can be used as early as 3 weeks old and provide a rapid onset of protection within 3 days against *Bordetella*. In very young puppies, signs of upper respiratory tract disease may occur one day after vaccination and may last up to 4 weeks.

To limit an outbreak in a breeding facility, it is essential to reduce the level of environmental contamination (reduction of crowding, adequate cleaning processes) and to limit stress. The quarantining of dogs entering the breeding facility, isolation with physical separation of the lactating bitch and puppies, and implementation of the forward-flow principle are essential to prevent the spread of CIRDC.

FROM WEANING TO ADULTHOOD

POST-WEANING NUTRITION

Nutrition plays a key role in the healthy development of growing puppies and kittens after weaning. The nutritional goal is to adequately support the increased nutritional demands of growth while taking care to avoid any excess that could lead to obesity or developmental disease. Both nutrient deficiencies and excesses can have long-lasting consequences.

Key nutrients

Puppies and kittens require increased levels of essential nutrients during their growth such as protein, amino acids, fat, fatty acids, vitamins, and minerals to support organs and tissue development.

- Calcium is a key nutrient required in increased amounts to support skeletal growth and development. However, calcium levels must be tightly controlled to avoid developmental bone disease in large and giant breed puppies. Excess dietary calcium stimulates calcitonin, which inhibits osteoclastic cells, thereby reducing bone resorption, and can cause abnormal remodeling of growing bones. Several studies have demonstrated developmental bone abnormalities in large and giant breed puppies if they are fed high levels of dietary calcium. However, similar studies in smaller breeds have not shown these same developmental abnormalities, demonstrating that this problem is specific to large (26-44 kg/60-100 lb adult body weight) and giant (> 44 kg/100 lb adult body weight) breeds.

- Essential fatty acid requirements are also increased during development. Docosahexaenoic acid (DHA), a long-chain polyunsaturated omega-3 fatty acid, is known to be especially important for retinal and brain development. Dietary enrichment with DHA has been shown to promote improved learning and memory in puppies and is recommended at increased intakes during gestation and the initial months of growth.

Gastrointestinal disturbances

During growth, the gastrointestinal tract is immature and can be more prone to gastrointestinal disturbances:

- Feeding a diet with highly digestible protein sources can help to improve nutrient utilization and stool quality.
- Including fermentable fibers (such as beet pulp and psyllium) and prebiotics (such as fructo-oligosaccharides) can also help to support the gastrointestinal microbiome and overall gastrointestinal health during development.
- Providing advice on an appropriate food transition is also valuable.

Energy requirements

While puppies and kittens require increased energy to support the demands of growth, the obesity epidemic has shown us that prevention should begin at an early age. In dogs, growth rates vary greatly between breed sizes, with small breeds reaching maturity at 10 months of age, while giant breeds (such as the Great Dane) may not achieve maturity until 24 months of age:

- In large and giant breeds, a growth diet with a lower energy density is recommended to promote a slower rate of growth, allowing for proper orthopedic development. Excess energy consumption results in the elevation of growth hormone (GH), insulin, insulin-like growth factor 1 (IGF-1), triiodothyronine (T_3), and thyroxine (T_4). Growth hormone and IGF-1 stimulate chondrocyte proliferation and differentiation, while thyroid hormone increases the rate of bone formation and resorption. With the alterations in these hormones due to excess energy, and accelerated growth, a mismatch occurs between the bone development and body mass, requiring immature bones to carry more weight than they can support. This leads to biomechanical stress and developmental orthopedic disease. With controlled

energy intake (70-80% of *ad libitum* feeding), Great Dane puppies have been shown to significantly reduce their risk for developmental bone disease.

- Neutering commonly occurs before the end of the growing period and requires additional care to ensure appropriate nutrition to support final development and a controlled energy intake to prevent excess weight gain and obesity. Neutering reduces energy needs while also increasing appetite and food intake; therefore, it is important to regulate feeding in the post-neutering period and regularly monitor weight to ensure that the puppy or kitten maintains a healthy body weight/condition by adjusting feeding amounts as needed.

Commercial or home-prepared diets?

Feeding a diet that has been formulated for growth or has undergone a feeding trial in growing animals is important to ensure the appropriateness of a diet. Labels of commercial diets should include a statement of nutritional adequacy indicating that they are suitable for growth and are equally appropriate for large and giant breeds.

A popular trend is the feeding of home-prepared diets, including raw meat-based diets, to dogs and cats but there are several key considerations when feeding a growing puppy or kitten **(Table 1).** First, recipes should be properly formulated for nutritional adequacy by a certified veterinary nutritionist to ensure all essential nutrient requirements are met and are not excessive to avoid severe health consequences. It is also important that recipes and instructions are followed exactly during preparation as any deviation in the amount of an ingredient, even a small one, could imbalance the formula. Furthermore, formulations should be reviewed regularly as needs may change as the puppies and kittens grow.

The second consideration is the risk of bacterial and parasitic contamination of raw meat-based diets, both to the pet and other household members. While the immune systems of puppies and kittens are immature and developing, it makes them more susceptible

to infections. Therefore, if owners want to continue feeding their pet a homemade diet, it is strongly recommended that they practice safe food handling and cook the raw ingredients to ensure the destruction of potential pathogens.

Table 1. Examples of essential nutrient deficiencies in puppies and kittens.

Protein & amino acids	*Slow growth, loss of body condition*
Arachidonic acid	*Lethargy, slow growth, poor coat*
Calcium and phosphorus	*Slow growth, poor appetite, bowing and swelling of forelimbs*
Potassium	*Restlessness, general weakness, muscle paralysis*
Copper	*Hair pigmentation loss, hyperextension of phalanges*
Zinc	*Slow growth, skin lesions*
Selenium	*Anorexia, depression, dyspnea, coma*
Vitamin A	*Bone growth abnormalities, deafness*
Vitamin D	*Rickets, lethargy*

OBESITY PREVENTION AND HEALTHY GROWTH

The concept that prevention is better than cure applies as much to obesity as to any other disease. Such strategies are most effective if introduced BEFORE obesity develops by identifying at-risk individuals. This involves understanding the factors that put dogs and cats at risk of obesity. For example, some breeds of dog are at increased risk *(e.g.,* Labrador Retriever, Pug, Beagle). Neutering is also a risk factor, especially in kittens, and especially if undertaken during the growth phase. Finally, a puppy or kitten identified to be growing too quickly may also be at risk. While prevention strategies for obesity should be considered in all puppies and kittens, the more risk factors present, the more closely they will need to be monitored.

Monitoring weight during the growth phase and beyond

A key strategy for prevention is to monitor the bodyweight of puppies or kittens regularly as they grow to check that their development is in line with expectations.

Weight monitoring should start early in life, for example, when the puppy or kitten first visits the veterinarian (~8 weeks of age). Weight checks can then continue regularly throughout the growing period until the animal reaches its adult size (10-24 months of age for a dog; 12-15 months for a cat). To ensure that growth remains on track (not too fast, not too slow), growth standards are now available for puppies and kittens, which are like the growth charts for children developed by the World Health Organization. Each chart displays a series of curves (called "centile lines") to confirm the pattern of growth. For example, if a kitten or puppy is growing too fast (crossing centile lines upwards),

Figure 1. Pediatric standard growth charts are available for puppies and kittens.

they are at risk of becoming overweight. Adjustments can then be made actively (see below) to rectify the issue. Such regular monitoring should ensure that the puppy or kitten reaches adulthood at a healthy weight. From this point on, the owner should continue to weigh them regularly (at the veterinary clinic or at home) to ensure that they stay that way through adulthood.

Measurements can be taken with electronic scales in your practice. Should this not be not possible, the pet owner could use their bathroom scales (weigh themself while holding the dog and then subtract their own weight) or some luggage scales (weight the puppy/kitten in a travel basket and subtract the weight of the basket).

Monitoring after neutering

Since neutering is a risk factor for obesity, owners choosing to have their puppy or kitten neutered (castrated or spayed) should pay close attention to body weight, for example, weighing every 2-3 weeks for a period of 3 months after neutering. Growth charts can be used to identify a change in growth patterns (see above) with any upward change in the growth slope, requiring a reduction in food intake.

Adjusting food intake

To ensure that the puppy or kitten's growth remains on track, pet owners can either adjust the amount fed or the exercise the pet gets, although the latter is easier in puppies than kittens! It might be surprising to many, but adjusting food intake is far more effective than increasing activity. Nonetheless, both are recommended because physical activity has other benefits that are also important to the well-being of the animal.

Here is some advice that can be given to pet owners:

- Measure food portions out accurately (see below), start by feeding the amount recommended on the food packet for your puppy's/kitten's weight and age.
- Weigh your puppy/kitten over the next 2-3 weeks and plot weights on a growth chart.
- If they are growing too quickly, consider decreasing the daily amount by 10%.
- If your puppy or kitten did not grow as much as expected, increase the daily amount by ~10%.
- Continue the process of weighing your puppy or kitten and adjusting the amount fed until their weight remains stable over time.
- Congratulations, you have now worked out the right amount to feed!

Accurately measuring food portions

To ensure that pet owners always feed the right amount, they need to be as accurate as they possibly can. This is most important for dry food because it has a high energy density and small errors can lead to large differences in the calories fed. Many owners like to use measuring cups because they are so simple. However, in a recent scientific study, measuring cups were found to be both imprecise and inaccurate. A more accurate method is to weigh food out using electronic weighing scales. This doesn't take much longer and will give the pet owner reassurance that they are giving the right amount of food. This also makes it easy to make the tiny adjustments that are necessary over time to meet a pet's varying needs (for example, if the puppy's exercise pattern has changed or their energy needs have altered).

Physical activity

Regular daily activity is recommended for the prevention of obesity. This can be walking (on or off leash), running, play activity *(e.g.,* ball chasing), swimming, or even hydrotherapy (using an underwater treadmill). The exact recommendation should consider any medical conditions that the puppy or kitten has, as well as their overall level of fitness. Finally, any regular exercise plan should also take into account what the owner can manage within their daily schedule (see chapter "Physical activity levels").

BETTER KNOWING THE PET

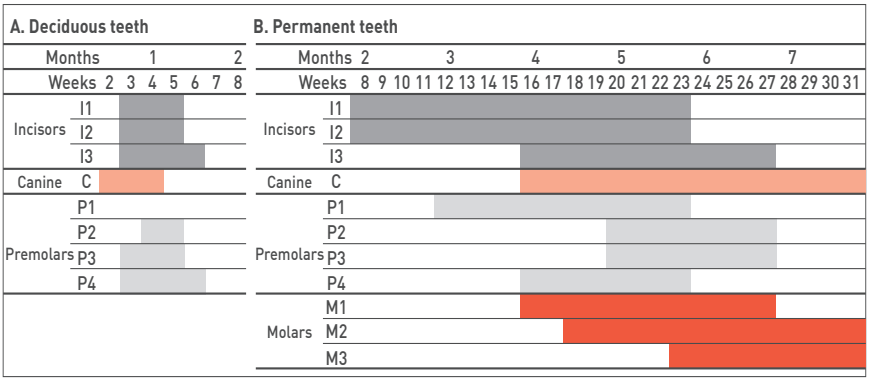
In some instances, the owner might be interested in learning more about their young pet. For example, determining the age of a rescued puppy or kitten as precisely as possible or investigating its breed origins and health markers using genetic testing.

Estimation of age

The estimation of a pet's age can be determined based on several parameters by observing its development and activity and following its body weight gain over several weeks or thanks to its dentition status **(Tables 1 and 2).**

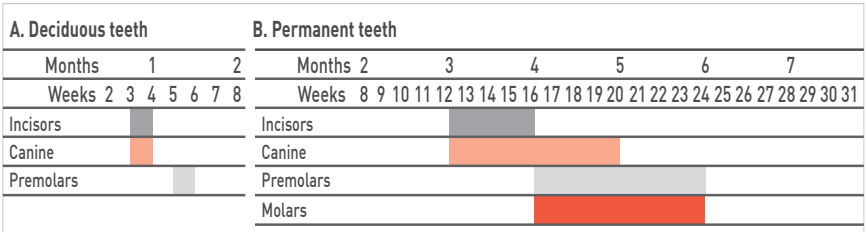
Dentition

Table 1. Interval between the earliest and the latest age of deciduous and permanent dental eruption in puppies.



From Roccaro M and Peli A. Age determination in dog puppies by teeth examination. *Vet. Ital.* 2020.

Table 2. Interval between the earliest and the latest age of deciduous and permanent dental eruption in kittens.



Skeleton

At birth, only the primary centers of ossification of long bones are present **(Table 3).** Growth plate closure can be evaluated using X-rays taking into account the breed size *(e.g.,* Chihuahua vs. Labrador or Singapura vs. Maine Coon). Closure of the fontanelle normally happens within a month after birth but remains persistent in some breeds *(e.g.,* Chihuahua).

Table 3. Timing of physeal closure in puppies and kittens.

	Age at physeal closure (months)	
Anatomic area	**Puppies**	**Kittens**
Humerus-proximal	10-13	18-24
Humerus-distal	6-8	4-4.5
Radius-proximal	6-11	5-7
Radius-distal	8-12	14.5-22
Pelvis	4-6	_
Femur-proximal	7-11	7.5-10
Femur-distal	8-11	12.5-19
Tibia-distal	8-11	10-12

Developmental milestones (Figure 1)

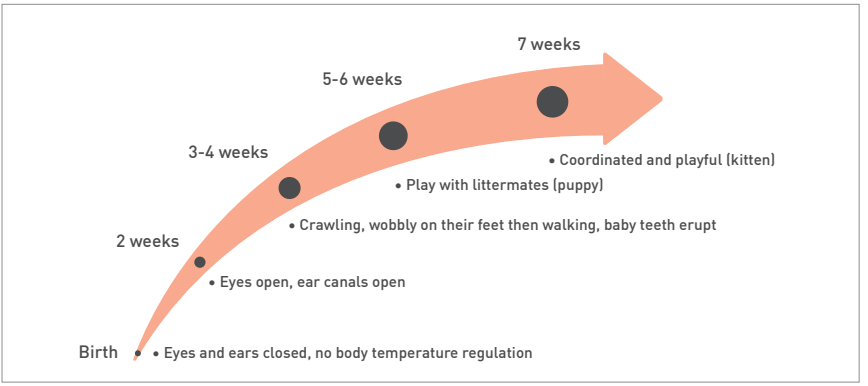


Figure 1. The developmental milestones are quite similar in puppies and kittens.

Genetic tests: breed origin and health markers

Genetic tests are now becoming available for cats and dogs which help in understanding a pet's origins. They are affordable and very easy to perform. Mostly they are performed using a simple buccal swab obtained from the pet's mouth that the owner sends to the laboratory for analysis. A few days to weeks later, the owner receives interpreted results with guidance for any next steps if required. Contacting a veterinarian for advice understanding genetic results is advised if there are any concerning findings.

Different companies offer different testing services. The main reason for testing is to investigate the breed origin(s) of a pet (sometimes even to verify the information given by the breeders in the case of purebred pets). DNA testing reveals an ancestry profile, but also provides information that could influence the pet's future health. Along with a breed profile, the pet owner can access health markers, trait markers, and information such as the blood type. Health markers are helpful when choosing future breeding partners to avoid heritable diseases.

Health markers can also help veterinarians prevent certain diseases and prescribe a prescription diet early enough to avoid problems. DNA testing is a huge area of research and in the near future this technology will permit the early detection and prevention of diseases such as diabetes or obesity and achieve healthier and longer lives for our pets.

PHYSICAL ACTIVITY LEVELS

During physical activity, puppies and kittens develop their locomotor skills, build up joints and muscles, and can interact in a positive manner with their environment. Physical activity is also a good way to release neurotransmitters such as serotonin that will promote the general well-being of the animal. Finally, physical activity promotes positive human-animal interactions.

Arousal spectrum

Different types of physical activity are associated with different arousal levels **(Table 1).** Searching for kibbles in the grass may provide mental stimulation and promote calm, focused activity with low arousal. Conversely, chasing or tugging on a toy is usually associated with high arousal. Pets should experience the whole spectrum of arousal and, in particular, learn how to shift between extremes and control their behavior during high arousal situations.

Limiting injury risk

In puppies in particular, intense or traumatic physical movement should be limited to avoid osteoarticular damage. If the activity is led by the animal, there is usually no upper limit as they will self-regulate. However, human-led activity may lead to over exhaustion if it's not adapted to the pet's abilities.

For both puppies and kittens it is critical to ensure good, undisturbed sleep so they can recover and develop. All family members should be encouraged to not disturb sleeping pets. Pets should have a comfortable resting space where they can retreat to when tired.

How much physical activity is beneficial for a puppy or kitten depends on their age, anatomical characteristics, health status, and temperament. While certain breeds are more active than others, individual differences within breeds are equally important. Therefore, rather than following rules that might not be adapted to an individual, owners should monitor their pet to detect signs of fatigue.

When using toys, the owner must ensure the pet's safety as pets might ingest pieces.

How to exercise a puppy

- The amount and type of exercise need to be adapted to the individual puppy. Owners should be able to detect signs of fatigue and adapt sessions accordingly.

Table 1. Types of physical activity and their potential benefit.

Physical activity type	Potential benefit
Play with a human	Positive human-animal interaction Bite inhibition/appropriate play Practice arousal regulation
Toy	Expression of hunting behavior
Puzzle feeder	Stimulate exploration and manipulation Slow down food intake
Interact with animals of the same species	Bite inhibition/appropriate play Practice arousal regulation
Olfactive exploration	Positive impact on mood
Chewing activity	Low arousal, to keep the pet busy while the pet owner is away
Following basic commands	Positive human-animal interaction Focus/mental stimulation
Digging	Exploration
Agility (and other sporting activity)	Focus Positive human–animal interaction Physical and mental stimulation

- Five minutes of activity one or twice a day per month of age may be a good starting place for activity. Following this approach, a 3-month-old puppy could receive a 15-minute morning walk and a 15-minute afternoon walk. In addition, puppies need to have the opportunity to eliminate after every feed, sleep, and every few hours, adding to their activity allocation.
- Activity sessions should be designed with the puppies' well-being in mind. Olfactory exploration of the environment is an important part of a puppy's learning experience and should be accommodated on walks.
- The timing of physical activity can help encourage desired behaviors. For instance, a physical activity session before leaving the house or later in the evening might help the puppy to better cope with human activity patterns. Ideally, physical activity should be paired with mental stimulation to help puppies feel calm and relaxed afterwards. Solely relying on (too much) physical activity to exhaust a puppy may not only be harmful to their health but may also create an endurance phenomenon. The puppy may need longer and longer outings to remain calm.
- A well-run puppy class offers an invaluable learning experience for puppies. These classes usually include mental and physical exercises alternating with play and rest periods.

How to exercise a kitten

- Kittens generally have a greater need for inter-cat play and for greater intensity and duration of play compared to adults.
- To prevent injury, kittens should have size-appropriate toys and puzzle feeders.
- Advise pet owners not to play with their hands to avoid scratching. Wand toys are a safe way to keep a distance.
- Make sure the pet owner is aware of the emotional status of the pet and can detect frustration.

The pet owner should offer an opportunity to play at least once a day **(Figure 1).** Toys or even tossing kibbles can be used to promote chasing behavior. Shorter sessions more often may be more adapted than one session that is too long and the kitten loses motivation.

Figure 1. To exercise their kitten, pet owners should offer an opportunity to play with a size-appropriate toy at least once a day. Look for the side position of ears – suggesting a high arousal emotional state.

HOW TO MANAGE UNDESIRABLE BEHAVIORS

Undesirable behaviors are a common source of abandonment and euthanasia. The veterinary team can help owners to understand their pet's behavior and recommend environmental enrichment and behavior modification techniques. Most of the time, undesirable behaviors are normal behaviors displayed at a time, location, or on an object *(e.g.,* scratching the couch) that are perceived as inappropriate by the pet owner for the human world. It is important to take pet owners' concerns into considerations.

Preliminary considerations

- Always rule out any medical reason or pain-related behavior.
- A common reason for undesirable behaviors, including aggression, in both dogs and cats is fear. A cat that is fearful of people may be more likely to hiss when approached and a dog that is fearful of other dogs may bark at them when on the leash. Therefore, owners should be advised to carefully select and socialize their pets to prevent fear-based behavior problems where possible.
- When pet owners contact the clinic because of undesirable behavior you may recommend making diary notes or even filming it so you can have a broader view of what's really happening.

Some of these undesirable behaviors can be prevented during puppy/kitten classes, such as appropriate play behavior or walking on the leash, as well as normal greetings.

Training classes held in the waiting room when the clinic is closed for patients may offer an opportunity to provide preventative behavioral advice and at the same time habituate pets to the veterinary environment. Classes could be run by interested veterinary staff or a dog trainer or behaviorist could be contracted for this purpose.

Medication may be considered: particularly in cases where animal welfare may be otherwise compromised where the human-animal bond is suffering, where medication could enable behavior modification, or if the pet is too fearful or aroused to learn. Medication should always be combined with a behavioral modification plan to help increase chances for success.

Undesired elimination

Undesired elimination behavior, which may include elimination in the house due to medical problems or anatomical malformation *(e.g.,* ectopic ureter), marking as a form of social communication, or which may be due to incomplete house training in the case of dogs or litter box management issues in the case of cats, is a common behavioral problem with pets. Preventative steps can be taken during puppy and kittenhood. Owners should be encouraged to discuss elimination problems with their veterinarian, and veterinarians should take any report of undesired elimination very seriously and investigate the underlying cause. Proper litter box management (number, location, substrate, cleaning frequency) for cats and appropriate walk frequency for dogs will help the pet adjust and learn the desired behavior. Pets should not be punished for inappropriate elimination. Repellents may be used as well as synthetic pheromones (in cases of stress-related behavior). Space organization may be adjusted to secure a quiet space that is easy to escape from and not accessible to other animals such as dogs.

Inappropriate play

A simple rule that pets should be taught is: "Teeth or claws on human skin = playtime is over."

Dogs and cats play differently from humans. They use their teeth or claws on each other's fur-covered skin and practice different types of social and predatory behavior, including chasing and grabbing each other in play. Both species not only need to learn how to play appropriately and inhibit some of their responses with their own kind, but also with humans.

For play with humans, toys can be used to redirect some of the play activity. Instead of chasing pant legs and grabbing or biting ankles, cats can grab and chase a toy pulled by a human and dogs can bite and pull the toy.

Dogs

Greeting people. Dogs greet a family member by jumping up and licking their muzzle. As humans appreciate this "friendly" greeting less than dogs do, an alternative behavior needs to be developed. A good alternative is that dogs must keep all four paws on the floor to receive human attention. As soon as the front paws leave the ground, the attention is withdrawn. Dogs should also learn to sit before they are allowed to interact with a person.

Chewing. Dogs enjoy chewing not only during teething, but also to reduce arousal or keep them entertained. For a dog, anything that feels pleasant in their mouth and is of appropriate size is a chew item. They need to learn which items are appropriate. It is best to remove potentially tempting, but unsuitable, items from the dog's environment and replace them with permitted chew items. Dogs should be rewarded with attention if they choose the desired item. If they make a mistake, the undesired item should be simply replaced with a desired item.

Leash pulling. The veterinary team need to remind pet owners that wearing a leash and being tethered to a human is not a "natural" behavior for dogs and needs to be learned. Pet owners should use the appropriate equipment. A harness or collar should never cause any discomfort or pain or restrict a dog's ability to breathe. Instead of using a device that causes pain if a dog pulls, the dog's behavior should be positively reinforced when walking on a loose leash. This training should initially happen in an environment with low stimulation before training in environments with more distractions.

When a dog pulls on leash, the owner should stop and wait for the dog to release tension on the leash or orient themselves to the owner. The dog learns that a "loose leash" means the walk continues, while tension on the neck means the walk stops. In parallel, owners should reinforce loose leash walking with attention or food rewards.

The dog should have a walk every day with opportunities to smell its environment, providing both physical and mental stimulation.

Owners should be clear when the dog is expected to walk by their side on a loose leash and when sniffing and environmental exploration is acceptable. Loose leash walking requires concentration and should – particularly during the initial phases of training – be expected only for short periods of time.

Barking. While barking is a normal behavior and part of the vocal repertoire of a pet dog, it may become an issue in some situations or if displayed for too long. To address this behavior, the veterinary team (thanks to the case history) needs to identify the context(s) and potential underlying emotions (bored, afraid, etc.) which cause the puppy to start barking. Then, the underlying cause should be addressed.

One possible approach to address barking is to interrupt the behavior by redirecting it and offering an incompatible behavior to perform *(e.g.,* giving a chew toy). In parallel, the barking trigger needs to be identified and addressed *(e.g.,* window access if the dogs barks at people passing the house).

It is always best to prevent the situation and get dogs gradually exposed to stimuli that may trigger barking. In all cases, owners should stay calm, not add to the general arousal, and try to redirect focus. It is also important for the animal to have enough regular physical and mental activity to help balance the arousal level.

Mounting. As veterinarians it is important to get clear information on the context in which mounting happens: which environment (location, people/animal involved, etc.) or emotional context (before, during, after). The causes can be diverse, from conflict-related situations to inappropriate play behavior to masturbation or some medical issues of the urinary tract (infection, skin allergies, etc.).

The veterinary team needs to take this issue seriously, discard (or treat) any medical condition, and advise on behavioral modifications:

- Pet owners should avoid the situation until the underlying cause has been identified. If safe to do so (because of the high arousal situation), pet owners may interrupt the sequence by gently removing the pet.
- Pet owners should redirect focus to other activities, put the animal in other locations, and, most importantly, not punish the pet.
- The pet owner should identify the trigger to limit the situation from happening. They may also consider an appropriate harness/short leash to prevent dogs from getting "out of control." They can seek professional help from dog trainers in doing so.

If hormones are the underlying cause, consider hormonal management, either permanently (neutering/spaying) or temporarily (implant/injection). See chapter "Reproduction control of dogs and cats."

Cats

Scratching. Scratching does not only serve as a means of sharpening their claws, but also as a form of communication. Scratch marks are a visual and olfactory "post-it note" for other cats. Scratching cannot be prevented, but only redirected to suitable items. For cats, a suitable scratching item is soft enough to make an impression with their claws and leave a visible mark. Scratching can be directed at vertical or horizontal surfaces. Scratch marks are usually placed in a prominent position in the room close to perceived important resources, such as the resting area or in doorways.

Suitable scratching posts and boards should be provided. Areas that are not supposed to be scratched but have been chosen by the cat

should be removed or, if that is not possible, covered with a less attractive material until the cat has learned to use the "appropriate" scratching items.

Countertop surfing. Cats enjoy heights and use their living space in all three dimensions. They like to explore their environment and reach elevated resting spots from which they can observe safely. A carefully designed living space with the needs of cats in mind is particularly important for indoor cats. A floor to ceiling cat tree can be useful here **(Figure 1).**

The more suitable, diverse, and elevated areas a cat has available to explore, the less likely they will explore the kitchen countertop. If a cat does explore the countertop, it is important to not inadvertently reward the exploration by leaving food out.

Petting intolerance. Some cats enjoy being petted by their owner. Whether petting (stroking) is perceived as enjoyable or not will depend on the context, the body part being petted, and a cat's individual preferences. Social grooming usually happens only if both partners are relaxed. Groomed body parts include the face, chin, and potentially long strokes over the back. Cats do not groom each other on their ventrum. Each cat may have unique preferences about which parts of their body they like to be petted. Owners should be aware of cat body language when relaxed, and when they are not enjoying the petting sessions. The first warning signs that petting may not be having a relaxing effect on the cat may be a twitching of the tip of the tail, ears being pulled back or flattened, or a change in pupil size.

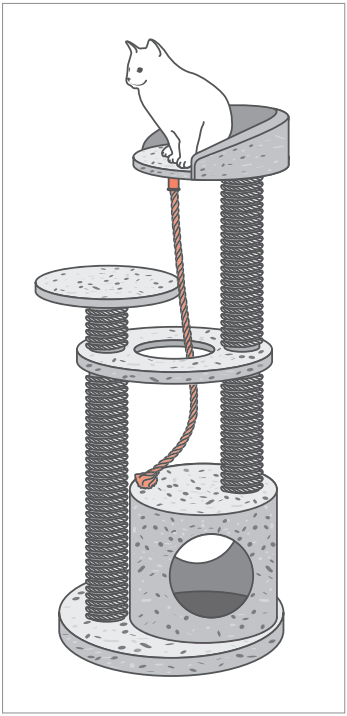


Figure 1. Example of a 3D design of the living space.

TRANSPORT OF PETS

Over the course of their lives, cats and dogs will make several visits to the veterinary clinic, and it's highly likely that they'll have to get there by car. Making sure they arrive in the best emotional and physical condition at the clinic will help achieve better examination conditions and increase the probability of reaching the right diagnosis.

Always secure and safe

For the safety of pets and pet owners, it is critical to secure the pet during transportation. Cats should be transported in a carrier. Dogs can be transported in a carrier/crate or secured with a harness attached to the seatbelt. If a carrier/crate is used, it should be safely secured in the car so that it cannot move in the event of an accident **(Figure 1).**

Make pets comfortable in the carrier/crate

Owners should train their pets to be comfortable in the transport carrier. The transport carrier can be offered as a resting option in the house. Pet owners should reward the pet first for entering and later for resting in the carrier for longer periods of time. Long-lasting food rewards, such as treats or puzzle feeders provided in the carrier can encourage this behavior. Finally, pets should be rewarded when the crate/carrier is closed and they are locked inside. Crate/carrier training can start early, even at the breeder's.

Make pets comfortable in the car

Pets should be exposed to short journeys first, if possible ending at a pleasant place or just coming straight back home. Cats in particular often experience car rides only on the way to and from the veterinarian, which might create a negative association with transport.

The temperature and ventilation should be adjusted so that the pet is comfortable. The driver must be aware of the unusual passengers and adapt accordingly, avoiding brisk driving/braking.

Some treats placed in the carrier during the car ride can help the pet form a pleasant association. It may not be appropriate for all of them *(e.g.,* car sickness).

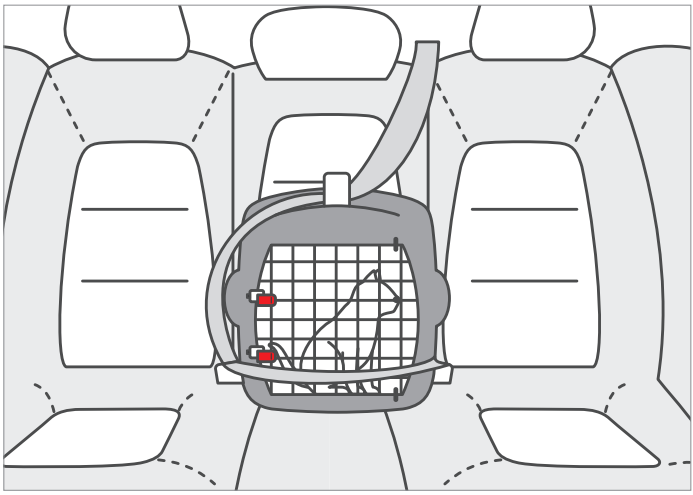


Figure 1. Car training is recommended right after the arrival of the pet in the family.

HOW TO TALK ABOUT NUTRITION WITH PET OWNERS

Effective communication is essential in building a successful veterinarian-client relationship. Practitioners rely on pet owner observations and history to help guide medical decisions and to identify areas of concern or risk for the patient. The same is true for nutritional recommendations by identifying risks related to improper nutrition or feeding practices.

Nutritional conservations

- When obtaining a dietary history from a pet owner, it is best to ask open ended "tell me" questions that will provide a more complete background. For example, instead of asking "what food do you feed your pet?", the veterinarian may say "tell me about what your pet eats over the course of the day." This approach will often lead to a more complete dietary history and will help to identify treats or other foods fed in addition to the primary pet food. The veterinary team can also ask pet owners to fill in a diet history **(Figure 1)** form before the consultation *(e.g.,* https://wsava.org/wp-content/uploads/2020/01/Diet-History-Form.pdf).

WSAVA Global Nutrition Committee

Short Diet History Form

Please answer the following questions about your pet

Pet's name: _____ Species/breed: _____ Age: _____

Owner's name: _____

Date form completed: _____

Gender: male ☐ female ☐ Neutered/spayed: No ☐ Yes ☐

1. How active is your pet? Very active ☐ Moderately active ☐ Not very active ☐
2. How would you describe your pet's weight? Overweight ☐ Ideal weight ☐ Underweight ☐
3. Where does your pet spend most of the time? Indoors ☐ Outdoors ☐ Indoors and outdoors ☐

Please list below the brands and product names (if applicable) and the amount of ALL foods, treats, snacks, dental hygiene product, rawhides and any other foods that your pet currently eats, including foods used to administer medications:

Food	Form	*Amount	Number	Fed since
Examples:				
• Purina Dog Chow	dry	1 ½ cups	2x/day	Jan 2010
• Science Diet Adult				
• Gourmet Beef Entrée	moist	¼ can	2x/day	Jan 2010
• 80% lean hamburger	pan-fried	3 oz (85 grams)	1x/week	May 2011
• Milk Bone medium	dry	2	3/day	Aug 2012

*If you feed by volume, what size measuring device do you use? _____

*If you feed tinned/canned food, what size tins/cans? _____

4. Do you give any dietary supplements to your pet (for example: vitamins, glucosamine, fatty acids, or any other supplements)? No ☐ Yes ☐

If yes, please list brands and amounts: _____

Information below to be completed by the veterinarian:

Current body weight: _____ Ideal body weight: _____

Current body condition score* ___/9 or ___/5 *Refer to the body condition scoring chart

Muscle Condition Score: normal ☐ mild wasting ☐ moderate wasting ☐ severe wasting ☐

wsava.org

Figure 1. Example diet history form, developed by WSAVA, that can be downloaded or adapted for the needs of your patients.

- With several routine visits during the first year of life, there are many opportunities to discuss the key role that nutrition plays in maintaining health.
  - The post-weaning period is a suitable time to discuss the importance of feeding a complete and balanced diet for growth as well as any breed size specific needs. This is also a good time to suggest offering a variety of textures (dry and wet foods) to help expose the pet to different foods at an early age. This can be particularly helpful in cats who can become selective if not introduced to taste and texture diversity early in life.
  - It's also a good opportunity to familiarize pet owners with methods to assess if their pet is growing well such as: growth rate (using a growth curve), stool quality (introducing owners to a puppy fecal score card), coat health, or playfulness.
  - At the time of neutering, it is important to discuss the expected change in the pet's energy needs and instruct owners how to properly adjust the amount fed to help their pet maintain a healthy body weight. This can also be a great time to introduce pet owners to body condition score charts, teaching them what a healthy body condition looks like and how to monitor for changes. This can be particularly helpful if body weight is not easily monitored at home. It is also a good opportunity to talk about suitable physical activity.

Growth charts are great tools to set up the discussion around healthy growth and weight management.

Figure 2. Nutritional conversations may include discussions of appropriate formulas for different growth periods and/or breed sizes as well as sensitivities and texture preference.

HOW TO ENSURE GOOD WELFARE ALONG THE CARE PATHWAY

Every effort should be made so that both owners and their pets can experience stress-free veterinary visits and ideally create positive memories – an investment for future interactions. A pet who is comfortable and relaxed in the clinic will be your best asset for safe and efficient future clinical exams. In contrast, pets who learn to be fearful or even fear-aggressive at the veterinary clinic may generalize this fear or express a similar behavioral strategy in other contexts outside the clinic.

Making it a positive experience

The veterinary team should help both the pet and the owner to be as comfortable as possible with the clinic and consultation experience. An owner who is relaxed will be easier to question and you will be able to obtain a comprehensive case history. Pets very easily pick up on the emotional state of their human counterparts; it is best if it's positive.

Particularly for young pets or pets that already show fearful behavior at the veterinary clinic, the veterinary team could promote regular visits, outside standard vaccine boosters, to check on topics such as education, house training, or to weigh the pet (for example to build and monitor a growth curve). Each of these visits offers a learning opportunity and every effort should be made to create a positive experience. This will help reduce stress and discomfort when the pet comes in for a procedure that might be perceived as uncomfortable by the pet.

The veterinary team should have a non-threatening approach **(Figure 1)** and provide rewards throughout the clinic visit. Many techniques are available to ensure the visit is a positive experience for the owner, pet, and veterinary team. Puppies and kittens that are relaxed enough should be encouraged to explore the exam room on their own terms. A synthetic pheromone spray diffuser may be used to make the pet feel safer to explore. Treats can be used to provide olfactory stimulation as well. The veterinary exam room should be designed in a way that it is safe for the pet to explore the floor and should not contain areas that are accessible for the pet but difficult for the veterinary team to access. While the pet explores the room, the veterinary team can start going over the case history with the owner.

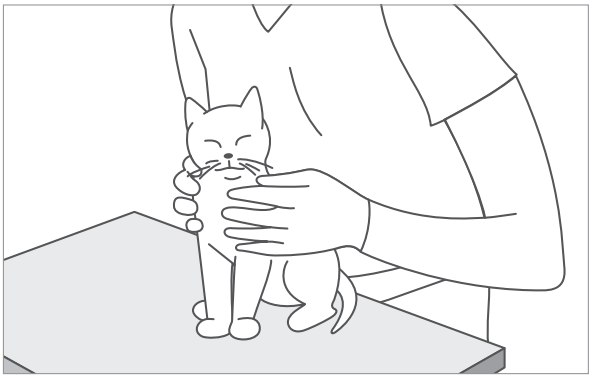


Figure 1. Low-stress handling approach.

At the clinic

Preparing for the veterinary visit

On arrival, puppies should be given the opportunity to eliminate before entering the clinic. Of course, elimination inside the clinic should never be punished.

Dogs and cats should have separate waiting rooms. The waiting time should be minimized for all pets, to the extent possible, limiting close contact with potentially sick animals visiting the clinic. Some pets and their owners might benefit from waiting in the car and being called in once the veterinary team is ready to see them.

Cat carriers should never be placed on the floor. Shelves or tables should be provided for owners to place their cat's carrier on an elevated surface.

In the exam rooms, appropriate floor materials should be used and cold, slippery, or reflective surfaces that could startle pets should be avoided. Very young patients in particular should not be placed on cold surfaces and an additional heat source may be required to maintain their body temperature. The veterinary team should limit sudden noises that could startle the animal.

If the pet is examined on a table, it should be stable and not slippery. Examinations on the floor may reduce the perceived level of discomfort, particularly for dogs, if they can be done in a safe and efficient manner **(Figure 2).**

Daily cleaning will help reduce or remove odors that might otherwise contribute to pet stress in the hospital setting. Strong detergent smells may also be perceived as aversive, and the chosen cleaning strategy should take this aspect into account.

The veterinary team should keep painful interventions as short as possible and, wherever possible, pair or immediately follow these interventions with positive experiences such as palatable treats or social interactions that are positively perceived by the pet. As there is no one size fits all approach, the veterinary team need to be aware of the emotional reactions of the pet and adjust their communication style accordingly.

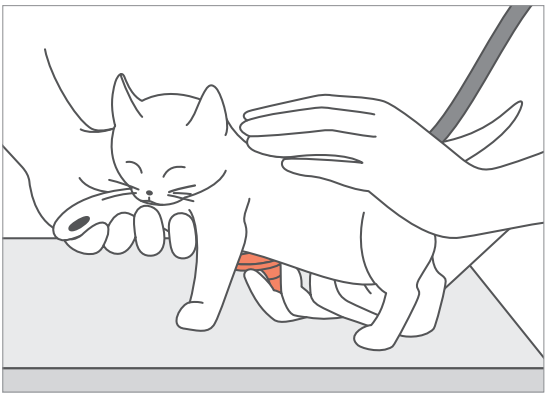


Figure 2. Adjust the examination steps and the location (on the floor or on the table) according to the animal's signs of discomfort.

When the puppy/kitten needs to be hospitalized

If the pet needs to be kept at the hospital for some time:

- Separate cats from dogs and pets that are not comfortable with conspecifics.
- Adapt the environment to help the young pet cope with the situation. For example, ask the pet owner to bring a piece of clothing or bedding with a familiar scent.
- For kittens, try to maintain the olfactory experience as stable as possible. Perform spot cleaning instead of cleaning the whole cage and thoroughly rinse with clean water after detergent use to remove any odor.
- Adapt noise and lighting conditions at night so puppies/kittens can sleep well.
- Offer puppies regular opportunities to eliminate. For kittens, keep the litter tray clean and offer a big enough cage so kittens can eliminate at a distance from their resting/feeding area.
- Provide tailored analgesia for optimal pain management to reduce any associated unnecessary discomfort (see chapter "Anesthesia and pain management in puppies and kittens").
- The veterinary team should be educated about low-stress handling (see below for educational resources). Allow pets to de-stress by providing some quality time either by enabling owners to visit or by giving staff the time to provide some positive interactions. Convalescent puppies and kittens should have interactive play opportunities outside their cage if possible and in ways that are appropriate for their physical limitations.
- During the socialization phase, it is particularly important to avoid any fear-eliciting situations as far as possible or to counterbalance them with plentiful positive experiences. In addition, their general socialization should be continued by providing positive experiences with the environment wherever possible.

When the animal needs treatment or medical post-intervention management at home

During its lifetime, a dog or a cat is most likely to receive hospital treatment at some point. It is therefore in the interest of the veterinary team that the pet owner prepares the animal for these situations before they occur.

- Make puppies and kittens comfortable with wearing a collar or harness. Most pets will wear a collar/harness during their veterinary visit for purposes of identification.
- Get them comfortable staying in a pet carrier (or crate for bigger dogs). Particularly for cats, a carrier will usually be used for transport to the veterinary clinic. Ideally, the cat should learn that the carrier is a safe place to relax in their home environment, reducing the likelihood that the crate itself will contribute to arousal or negative emotions in the veterinary clinic.
- Pets should learn to be comfortable riding in the car or other means of transport used to get to the veterinary clinic.
- From puppyhood/kittenhood on, puppies and kittens should experience being touched in a positive context. They should learn that manipulations of the paws, teeth, or ears might require a brief period of staying still which is then rewarded with a positive experience. The more positive experiences a puppy/kitten makes in the context of handling, the less likely it is that one slightly negative experience will cause fear or distress.

Pet-friendly practices not only offer a safer working environment for the veterinary team and a more pleasant environment for pets and their owners, they may also aid client retention and take an active role in preventing behavior problems in a puppy or kitten's lifetime. Some clinics choose to appoint one of their staff members to educate clients on the topic and then implement pet-friendly practices in their clinic setting.

- Pets should be trained to be comfortable on a table if this is required for the veterinary examination. Large dogs can usually be examined on the floor. Not only should the pet be prepared for the administration of treatments, but owners should be educated about how to correctly give treatments at home. Supporting materials such as leaflets and videos can help. The veterinary team should also take the time during the consultation to ensure the owner has understood and practiced the administration several times.

Educational resources

Cats

- https://catfriendlyclinic.org
- https://catvets.com/cfp
- https://vetfocus.royalcanin.com/en/practice-management/making-your-practice-more-feline-centric

All pets

- https://fearfreepets.com
- https://cattledogpublishing.com/why-and-what-is-low-stress-handling/

PUPPY CONSULTATION PROTOCOL

Puppy owners expect close support during the first months of their pet's life. By following puppy consultation protocols, the clinic can offer a consistent journey, especially if owners see different clinicians, helping to standardize the level of care and quality of service for every puppy and pet owner. The examples of protocols presented below can be considered as a basis for each clinic to design their own protocols.

Consultation at two months: welcome and puppy pack

Prevention
Introduce identification, including microchipping and registration (if not already done)
Describe the puppy's health support during the first year
Vaccinate while distracting the animal
Explain the appropriate anti-parasitic treatments and demonstrate how to administer them
Discuss insurance & neutering

Nutrition
Explain the growing puppy's nutritional needs
Discuss the key points of puppy food: • Energy concentration • High levels of high quality/highly digestible protein • Omega-3 essential fatty acids (DHA) • Prebiotics to support a healthy microbiota
Advice if the owner would like to investigate homemade, cereal-free, gluten-free, or other diets

Socialization & education
Discuss the key aspects of socialization and education
Explain the puppy's behavioral needs; relationship to human beings, daily education, and desensitization
Discuss differences and advantages of harness vs. collar
Give some tips on managing house training and educational difficulties

Consultation at 3 and 4 months: check-up

Prevention	Nutrition	Education
Explain breed predispositions (including BOAS, osteoarthritis, skin and eye conditions), surveillance, and the interest of screening	Take stock of the current nutrition of the puppy, advise on a growth diet	Take stock of the initial weeks of ownership, answer questions, assess how house training is going
Use growth chart to assess puppy's healthy growth	Reminder of the key points of quality food: • Balanced energy and Ca/P intake • Highly digestible nutrients • Omega-3 essential fatty acids (DHA)	Introduce the rules of education and life to the puppy so it can live safely in a human world
Vaccinate while distracting the animal	If neutering is planned, discuss the nutrition and the specific future needs of a neutered dog (risk of obesity, urinary calculi)	Explain the puppy's need for activity, education, and interactions with humans and other dogs
Discuss hygiene and demonstrate coat maintenance, eyes, ears, and teeth cleaning, clipping claws – depending on lifestyle		Talk about puppy school, agility, educational games, etc.
Discuss neutering. If planned, discuss the pre-anesthetic checks and blood tests, the procedure, and post-operative care		Check for stress signals in the environment (destruction, excessive vocalization, anorexia, excessive reactivity, etc.)

At each visit, conduct a gentle, thorough, full clinical examination (from the tip of the nose to the end of the tail) explaining each step.

Pre-pubertal consultation at six months

Prevention	Nutrition	Education
Explain the growth rhythms by breed and individually according to the puppy curve	Switch from 3 to 2 meals a day. Introduce slow feeders and food puzzles: extend mealtime while the latter also stimulates foraging behavior	Check clinic behavior and interaction/obedience with the owner
Check descent of the testicles and if not, explain what to do	Prescribe the right nutrition (breed, sensitivity, etc.) adapted to the puppy	Take stock of home behavior and possible changes in the coming months and explain how to react and rectify
Explain the steps of adult follow-up: next appointment in 6 months for the vaccination booster and annual follow-up. If the pet is healthy, reassure and congratulate the pet owner	Prevent obesity	Remind about the rules of education and promote various educational activities and training to perform with the puppy

The same protocol can be followed for a post-neutering consultation. In this case, you should include some key food features in the nutrition topic such as reducing energy density, explaining the risks associated with new energy needs, and physiology (obesity/incontinence).

KITTEN CONSULTATION PROTOCOL

Kitten owners expect close support during the initial months of their pet's life. By following kitten consultation protocols, the clinic can offer a consistent journey, especially if owners see different clinicians, helping to standardize the level of care and quality of service for every kitten and pet owner. The example of protocols presented below can be considered as a basis for each clinic to design their own protocols.

Consultation at 2 months: welcome and kitten pack

Prevention
Gently guide the kitten out of the carrier
Introduce the vaccination protocol and the importance of identification, present the kitten growth chart
Vaccinate while distracting the animal to limit stress
Explain appropriate anti-parasitic treatments and offer to demonstrate how to administer them
Discuss insurance and neutering

Nutrition
Explain the growing kitten's nutritional needs
Discuss the key requirements of kitten food: • Energy concentration • High levels of high quality/ highly digestible protein • Prebiotics to support a healthy microbiota • Omega-3 essential fatty acids (DHA) Offer a recommended diet, using a daily allowance software (such as the Royal Canin feeding calculator) to calculate the meal portions
Give advice if the owner would like to investigate homemade, cereal-free, gluten-free, and other diets

Education
Explain a cat's behavioral needs and their relationship with humans
Get the cat used to being handled and demonstrate how to examine its body (eyes, ears, mouth, etc.) Recommend play using toys rather than hands
Give some tips to manage undesirable behaviors

Consultation at 3 months: check-up



Prevention	Nutrition	Education
Take the clinical history and guide the kitten out of the carrier	Take stock of the current nutrition of the kitten	Discuss the first few months and start with simple education
Explain then administer the vaccination, distracting the kitten to reduce stress	Introduce the concept of "nutrition education" (by providing a variety of forms, tastes of food, ad lib feeders, etc.)	Establish the basic environment and house rules (how to discourage unwanted behavior, etc.)
Demonstrate how to administer deworming and flea treatment	Food puzzles: stimulate normal behavior and extend mealtimes by complicating access	Advise how to enrich the cat's environment with 3D spaces and separate quiet zones to eat and rest
Discuss neutering		Talk about cat marking behavior (claws, urine)

Consultation at 4 months: check-up



Prevention	Nutrition	Education
Explain breed predispositions	If neutering is planned, discuss the nutrition and specific needs of a neutered cat (risk of obesity, urinary calculi)	Check for stress signals in the environment (marking, excessive vocalization, anorexia, excessive reactivity, always hiding, etc.)
Discuss and demonstrate coat maintenance, cleaning the eyes, ears, teeth, trimming claws, and so on depending on lifestyle	Advise a growth diet	Talk about educational games
Explain then administer the vaccination, distracting the kitten to reduce stress	Discuss the key points of a quality food: • Energy concentration • High levels of high quality/ highly digestible protein • Prebiotics to support a healthy microbiota • Omega-3 essential fatty acids (DHA)	Take stock of training: it's possible to train a cat to do things (sitting, etc.) just as you can with a dog
Discuss neutering if planned, discuss the pre-anesthetic checks and blood tests, the procedure, and post-operative care		
Outline the steps of adult follow-up		

At each visit, conduct a thorough but gentle, full, clinical examination (from the tip of the nose to the end of the tail) explaining each step.

Consultation around neutering

Pre-anesthetic
Check if the kitten has fasted
Explain the plan for the day and remind the owner of the important points
Check identification, give explanatory documents, and gain informed consent with a signature
Listen to and discuss owner concerns and establish how to keep them informed

Post-operatively
Explain what happened during the kitten's procedure
Discuss any prescriptions
Advise the owner on post-operative care, including nutrition and any exercise restrictions
Show the kitten's wound and advise about wound care, any problems, or owner concerns and provide an emergency contact number

Post-operative consultation

History and physical examination
Discuss the post-operative health and behavior of the kitten with the owner (appetite, energy levels, etc.)
Complete a physical examination, including checking the wound, to ensure the kitten has recovered properly from the operation
Explain the steps of adult follow-up: next appointment in 6 months for vaccine booster and annual follow-up. Establish a long-term relationship with the pet and the pet owner

Nutrition
Important point of prevention: explain the risks associated with the changing energy needs and physiology of neutered cats (obesity, urinary calculi)
Prescribe the right nutrition and discuss the key points of quality food: • Reduced energy concentration • Prevention of urinary calculi

HOW TO ORGANIZE PUPPY OR KITTEN AWARENESS SESSIONS?

Kitten and puppy awareness sessions – educational get-togethers for new pet owners – are frequently organized by veterinary clinics, helping to establish the clinic as a place of reference for the health and well-being of cats and dogs in the minds of pet owners. The good practices presented below will help you to develop your own puppy or kitten owner sessions.

Objectives of the puppy or kitten awareness sessions

Create a relaxed atmosphere of sharing and conversation to provide knowledge to pet owners in a fun way (quiz, games, etc.).

Strengthen your relationship with pet owners.

Reduce cat and dog treatment rates by providing pet owners with a better understanding of cat and dog needs.

Reinforce the expert image of the veterinarian and nurse teams.

Practical considerations

- Groups of no more than 15 pet owners are preferable: by invitation and registration only. Reconfirm attendance 24 hours before the event.
- Animal attendance is not required – and not recommended for kittens. If puppies are coming, they should be in good health to limit the risk of disease transmission.
- It takes time to organize and run a kitten/puppy awareness session and this must be considered. Choose calmer times of the year to manage the organization of these events more effectively. Even though Saturdays are usually quite busy, it's still the best day to welcome new pet owners.

In addition, the veterinary clinic may promote puppy/kitten classes where the focus this time will be on training pets and pet owners on basic commands. It could be relevant to work with external behaviorists/pet trainers to deliver the appropriate support. Sometimes classes may even be run at the veterinary clinic mainly for puppies.

Example of puppy/kitten workshops organization

The following example is based on the active participation of three members of the veterinary clinic: two nurses and one veterinarian to manage a group of 15 pet owners **(Table 1).** The afternoon is shared in three 55 min-workshops for five pet owners each with a five-minute break between each workshop.

Table 1. Example organization of a 4-hour workshop of 15 people split into 3 groups.

	GROUP 1 (5 people)	GROUP 2 (5 people)	GROUP 3 (5 people)
2:00 pm	Welcome/short presentations/organization of workshops		
2:30 pm	Health and safety	Care and hygiene	Nutrition
3:30 pm	Nutrition	Health and safety	Care and hygiene
4:30 pm	Care and hygiene	Nutrition	Health and safety
5:30 pm	Conclusion/final discussions, questions, and answers		

Conducting the workshops

It's important to support the key messages of the workshops with visual tools and/or materials. Some pet owners may have a visual memory and others may have an auditory one, so it's important to do everything you can to capture the attention of the whole audience.

Workshop on nutrition

1. Food and the puppy/kitten (nutritional needs, food preferences, rationing, transitions, etc.).
2. What is healthy nutrition?
3. Nutrients and health benefits of puppy/kitten food.
4. Nutrients and health benefits of food for adult spayed/neutered cats and dogs.
5. Wet food, the value of combining with dry food.

Workshop on hygiene

1. How do you clean a cat or dog's ears?
2. How do you clean their eyes?
3. How do you cut their claws?
4. For kitten owners: practical cat litter management.

Workshop on preventive care

1. Fleas/worms and the role of deworming and treatments against ectoparasites.
2. What are ectoparasiticides, endoparasiticides, and their roles?
3. Vaccination, veterinary visits, and boosters.
4. Weight management and monitoring.
5. Pros and cons of neutering.
6. Clinic services (dentistry, senior checkups, ultrasound, hospitalization, etc.).

Each workshop can conclude with a quiz to make it more fun. Here is an example of a quiz for a kitten session:

- **Nutrition/behavior:** how many meals does a cat eat a day? (15 to 20 small meals).
- **Behavior:** how many hours does a cat sleep a day? (Approximately 15 hours a day).
- **Overweight:** in terms of energy intake equivalence: if a cat is given 30 g / 1 oz of ham fat, how many croissants would that be for a human? (12 croissants). If a 4 kg / 10 lb cat gains 1 kg / 2.5 lb in weight, how much would this represent for a 65 kg / 145 lb human? (answer: +16 kg / +36 lb).
- **Spaying/neutering:** how many kittens do you think can be born from a pair of cats in four years? (20,736).

REPRODUCTION CONTROL OF DOGS AND CATS

Controlling the reproduction of domestic carnivores is key in the breed selection and conservation process. Limiting reproduction by removing the gonads or decreasing fertility is also key for disease prevention at the individual level and for ecosystem preservation at the population level (cats mainly). It can be achieved surgically or medically. Part of the recommendation is also to enable pets to live in anthropocentric environment (limiting marking, roaming, etc.). It is important to have an individual approach for the preferred treatment option in agreement with the pet owner when there is one *(i.e.,* shelter).

Indications for neutering

Prevention of reproduction

Neutering is currently the mainstay of feral cat population control campaigns. However, to have a significant impact on the cat population, more than 2/3 of the males or 50% of the females need to be neutered.

Neutering is also used in domestic animals to prevent unwanted mating and pregnancy. But don't forget that it takes a few days after surgical neutering for the male to become sterile (sperm are still present in the genital tract after orchiectomy).

Treatment of genital pathologies

Surgical spaying is indicated for the treatment of many genital pathologies in non-breeding females: uterine (pyometra, mucometra, metrorrhagia, unwanted pregnancy), ovarian (cyst, tumor), vaginal (hormonal tumor, ptosis), and mammary (mastosis, diagnosed mammary tumor).

In males, there are fewer genital indications: testicle (tumor, orchitis, ectopia, torsion), prostate (BPH, prostatitis, prostate cavity), and hepatoid adenoma.

Prevention of mammary tumors

Spaying young female dogs and cats significantly reduces the risk of mammary tumors **(Table 1).**

Table 1. Influence of spaying on the reduction of the risk of mammary tumors in cats and dogs.

Reduction in relative risk of mammary tumors in female cats according to age at spaying.

Age of spaying	< 6 months	6-12 months	12-24 months	>24 months
Relative risk of developing a mammary tumor	9%	14%	89%	100%

Decreased risk of developing a mammary tumor in female dogs according to age of spaying.

Age of spaying	< 1st estrus	< 2nd estrus	< 3rd estrus	>2.5 years
Reduced risk	99.5%	92%	74%	No effect

Prevention/treatment of undesirable male behavior

In the majority of cases, early neutering prevents the development of secondary sexual behavior, including urinary marking. For example, less than 3% of early neutered cats develop urine marking. Neutered cats also have less malodorous urine and fewer incidents of aggression between males.

In dogs, neutering is often motivated by a desire to reduce undesirable behavior. Although neutering can be effective, it does not systematically eliminate signs and can sometimes make them worse **(Table 2).**

Table 2. Influence of neutering in adult dogs on undesirable behaviors.

Behavior	Improvement	Worsening
Outdoor urine marking	0-50%	
Internal urine marking	50-69%	
Inter-male aggression	0-60%	5-10%
Aggression towards humans	0-22%	4%
Runaway	16-60%	
Mounting	25-57%	5%

Other indications

Neutering has various therapeutic indications in hormone-dependent pathologies: diabetes mellitus (progesterone induces an increase in the production of growth hormone by the mammary tissue, leading to insulin resistance), peri-anal adenoma, and some alopecia of the flanks.

Methods of neutering

Surgical

1. Ovariectomy or ovariohysterectomy

Removal of the uterus is only recommended in the following cases: uterine pathology, current pregnancy, and in a bitch with a history of chronic vaginitis. In all other cases, ovariectomy is sufficient and provides a less invasive procedure.

2. Oviduct ligation, vasectomy, and epididymectomy

It is possible to prevent reproduction (neutering) without removing the gonads. This is useful for managing stray populations, but also for owners who do not wish to see any changes in their pets. The method is said to be reversible if only ligation is performed (epididymis, vas deferens, or uterus). The procedure is identical to an ante-scrotal castration.

After vasectomy, sperm are still collected by masturbation for between 2 and 21 days in dogs and up to 49 days in cats.

Vasectomy involves tying off (and possibly cutting) the vas deferens **(Figure 1).**

Epididymectomy is a new approach and involves cutting off part of the tail of the epididymis. It is quicker and easier than a vasectomy.

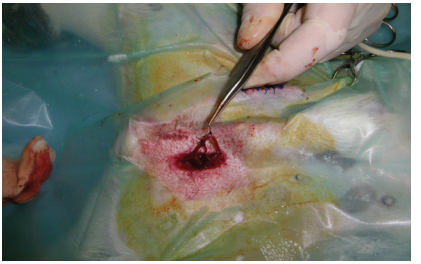


Figure 1. Note the double ligature of the vas deferens before the dissection between the 2 ligatures.

3. Surgical access

In females, the ovaries can be accessed via the flanks or the midline.

The midline route is most often recommended: faster preparation and operative time, better assessment of the uterus, small incision if the operation is mastered (< 3 cm) **(Figure 2).** The flank route is preferred in feral cats and sometimes in working dogs (reduced risk of postoperative hernia, faster return to exercise). The flank route allows only a

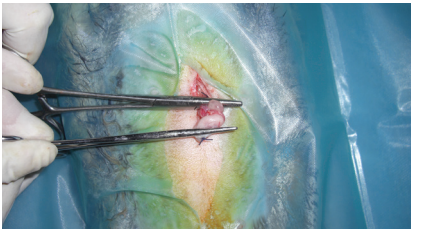


Figure 2. Ovariectomy of a cat via the linea alba. Note the ligation of the ovarian pedicle and placement of a clamp caudally (top) and similarly for the tip of the uterine horn. In the middle cat, the ovary is visible without the bursa.

very partial assessment of the abdominal cavity, and a risk of hair changes at the surgical site has been described; this route is not recommended in obese animals or in the case of early neutering (before 12 weeks).

Laparoscopy is of little interest in the bitch once the "hook" technique is mastered. As the ovarian bursa is often large, the incision required to remove it is almost equivalent to a laparotomy.

Ante-scrotal castration is preferred if the scrotum is not large or if there is an ectopic testis. Scrotectomy is preferred in dogs with a very large scrotum (following a large testicular tumor, pendulous testicles in certain breeds *(e.g.,* Basset Hound), or scrotitis).

For neutering without scrotal ablation, the skin of the scrotum, which is very sensitive in dogs, must not be cut or rubbed during surgical preparation. Neutering can be performed with the testicle uncovered in large dogs and cats and with the testicle covered in small dogs (unopened vaginal parietal tunic). The open technique allows ligation around the vessels (less risk of bleeding) **(Figure 3),** while the covered technique limits the risk of peritoneal contamination. In the case of testicular ectopia, the testis must be precisely localized in order to determine the best approach. Inguinal ectopic testes are sometimes not palpable (particularly in cats) and careful ultrasound examination is required (see chapters "Antimicrobial therapy best practices" and "Anesthesia and pain management in puppies and kittens").

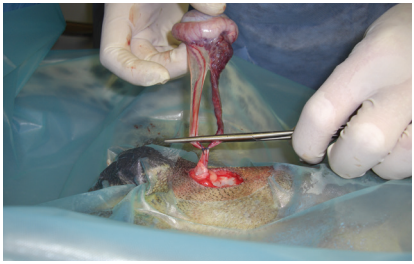


Figure 3. Neutering with uncovered testis. Ligation of the vas deferens and vasculature and clamping before dissection.

Medical

1. Deslorelin acetate implant

A GnRH superagonist can be used to chemically castrate male and female dogs and cats.

In males

There is a latency period between implantation and a drop in testosterone, followed by a reduction in semen quality leading to infertility.

It should be noted that the latency period, the duration of efficacy, and, therefore, the effective duration of neutering varies from individual to individual and from dog to cat.

In dogs, it takes approximately 4 weeks for complete cessation of libido and at least 6 weeks for azoospermia. The return to fertility varies greatly from dog to dog, but statistically it takes longer as the size of the dog decreases, from 150 to over 500 days, with an average delay of 12 to 18 months.

Caution should be exercised when using the implant in prepubertal males. Prolonged histological changes in the testes have been reported.

In domestic cats the variability of response is even greater depending on the individual. The majority of cats are sterile 3-4 months after implantation. Many cats regain fertility between 15 and 24 months after implantation. Use in the pre-pubertal period (3 months of age) can delay puberty until around 18 months of age.

- **In females**

The implant is often used in breeding cats where the interestrus interval and winter anestrus are very short. The duration of efficacy varies from 12 to 24 months. It is possible to shorten the spaying period by removing the implant in the months following its application. In most cases, a return to heat is observed in the weeks following removal. Although rare, adverse effects have been reported: ovarian cyst, persistent heat, pyometra and mucometra, and no return to heat after 2 years post-implantation.

In bitches, the implant can be used to delay the estrus cycle by inducing heat at the chosen time. By injecting the implant in the prepubertal period (preferably before the age of 4 months), one can prevent the onset of heat and extend the duration of its effect.

2. Neutering by vaccination

Several vaccines have been developed targeting stray animals (particularly cats). The efficacy of the GnRH vaccine (Gonacon®) is highly variable between individuals and the development of a persistent granuloma at the injection site is often reported (not recommended due to the risk of fibrosarcoma).

In contrast, the AMH vaccine (not yet on the market) shows very promising results. It seems to be fully effective for at least 2 years (the duration of the trial) and no adverse effects have been reported. This is probably the way of the future.

3. Intra-testicular injections

Intra-testicular injection of 20% calcium chloride leads to neutering in 4 to 6 weeks. Although the duration of neutering has not been studied, it appears to be permanent after a single injection.

Injection of zinc gluconate provides neutering in 8 weeks and for at least 4 months. Treatments may cause painful orchitis in the days following the injection.

Consequences of neutering and influence on the choice of spaying age and spaying method in particular

1. Weight gain

Between 18% and 44% of the general dog population is obese, and considerably more in the neutered cat population.

The risk of weight gain is rapid after neutering, particularly aided by a significant increase in appetite (within a few weeks in cats). Sex steroids (estrogen and testosterone) have been reported to be involved in the control of satiety as appetite suppressants. Alterations in lipid and muscle metabolism (via IGF-1, prolactin, leptin, and insulin) have also been implicated in body fat.

Control of food intake (from neutering onwards) through an appropriate ration plan, combined with weight monitoring during the first six months, appears to significantly reduce the risk of obesity.

In cats, according to some authors, early neutering (before 4 months) seems to reduce the risk of obesity. The period of polyphagia coincides with the period of rapid growth.

2. Behavior

Neutering results in a loss of neural plasticity. This can have detrimental consequences for the effective management of dogs with behavioral problems, particularly if neutering is performed in the peripubertal period. It has been reported that some neutered dogs show an increase in "phobic," "anxious," and "aggressive" states.

Neutering appears to have other effects on both males and females that require further study: reduced learning (memory tests), reduced cognitive capacity in older animals, etc.

The effects of neutering on escape, marking, and aggression are detailed above **(Table 2).**

3. Osteoarticular disease

Early neutering (before puberty) delays the closure of the epiphyses of the long bones (estrogen dependent). Early neutering therefore tends to increase the height (at the withers) of dogs and cats. However, delayed closure of the growth plate does not increase the incidence of Salter-Harris fractures.

Neutering of growing animals seems to increase the prevalence of certain pathologies in certain breeds (cruciate ligament rupture, coxo-femoral dysplasia, intervertebral disc herniation, etc.) and according to sex **(Table 3).**

4. Urinary incontinence

Spaying of the bitch can lead to urinary incontinence in the weeks to years following it, in three quarters of cases within the first three years.

In particular, incontinence is associated with a defect in the contraction of the smooth muscle of the internal urethral sphincter (autonomous continence system), a defect in the relaxation of the vesical muscle (early increase in vesical pressure during filling), a reduction in the length of the urethra (more distal bladder, reduced sphincter tone), and possibly weight gain (adipose tissue which increases intra-abdominal pressure). According to studies, bitches weighing more than 15-20 kg have a much higher risk than small breeds (< 8 kg: 1.4% vs. > 8 kg: 9.1%). Some large breeds, such as German Shepherds, have a much lower risk (6%), while others seem to be predisposed in certain lines (Boxers, Dobermans, Golden Retrievers).

Male dogs can also suffer from neutering incontinence. This is exceptional but more difficult to treat. The clinical presentation is often different (dripping urine when walking vs. lying down in bitches).

The age of neutering does not appear to affect the risk of incontinence but neutering before 4 months of age exacerbates the clinical signs and makes treatment less effective.

5. Genital development and chronic vaginitis

Pre-pubertal spaying of the bitch prevents genital development. Bitches with vulvar hypoplasia, vulvar entropion, or vestibulo-vaginal stenosis associated with vaginitis are at greater risk of developing chronic vaginitis, sometimes complicated by chronic recurrent cystitis in adulthood. In this context, it is advisable to wait until puberty before considering surgical spaying.

6. Neoplastic processes

Neutering causes significant hormonal changes in the body. On the one hand, the removal of the gonads leads to the suppression of testosterone, estradiol 17b, and progesterone (in females), as well as some of their derivatives (especially DHT). On the other hand, surgical neutering (as opposed to medical) leads to a very significant increase in the secretion of LH and FSH by the anterior pituitary.

Most organs and many cells have receptors for both sex steroids and LH: adrenal cortex, blood vessels, ligaments, cartilage, bone, lower urinary tract, lymphoid tissues, skin, etc.

As a result, more and more studies on dogs are implicating these changes (particularly in LH expression) in the promotion of various cancers, especially when young adult dogs are neutered.

The issue is extremely important because cancer is so prevalent and devastating in certain breeds.

Table 3 summarizes at-risk breeds according to age at neutering based on current data. Here are just a few examples:

- One study showed a 3-fold increased risk of lymphoma in neutered Golden Retrievers. Conversely, no effect of neutering was observed in Labrador Retrievers.
- Osteosarcoma is more than 2 times more common in Rottweilers neutered before the age of 3 years than in intact dogs or dogs neutered later.
- Prostate cancer is reported to be more common in neutered dogs in only one study (small population, single breed), although its prevalence in dogs remains very low (< 0.6%).
- Although the data are still limited, veterinarians should be aware of the possible promotion of certain cancers that are common in different breeds and thus adapt their neutering recommendations to the owner depending on the breed, sex, age, and lifestyle of their pet.

7. Dysimmune diseases

Estrogens increase antibody production and have anti-inflammatory and antioxidant effects. Testosterone inhibits humoral immunity. Finally, puberty leads to atrophy of the thymus.

Two studies seem to indicate that neutering has an influence on the increase of immune diseases (in particular hypothyroidism).

There are not enough studies to conclude that neutering has a negative effect, but the effect is real and probably underestimated.

Conclusion

Neutering of young animals to prevent disease and improve their health is a thing of the past.

It is now a treatment that must be considered according to the species, breed, age, lifestyle, and behavior of the patient and the motivation of the owner. The method of neutering (whether medical or surgical) must also be carefully considered.

In addition to contributing to individual health management, neutering is essential for the management and well-being of global dog and cat populations, as well as for the preservation of biodiversity and natural resources.

Table 3. Suggested guidelines according to known disease risks by dog breed and age of neutering.

	Males					
Breed	**No neutering**	**Age of choice**	**> 6 months**	**> 1 year**	**> 2 years**	**Risk/Reason for delay**
Australian Cattle Dog		x				
Australian Shepherd		x				
Beagle				x		Joint disease
Bernese Mountain Dog					x	Joint disease
Border Collie				x		Tumor
Boston Terrier				x		Tumor
Boxer					x	Tumor
Bulldog		x				Joint disease
Cavalier King Charles Spaniel		x				
Chihuahua		x				
Cocker Spaniel			x			Joint disease
Collie		x				
Corgi (Welsh), Pembroke and Cardigan			x			Disc hernia
Dachshund		x				
Dobermann Pinscher	x (or before one year)					Tumor
English Springer Spaniel		x				
German Shepherd					x	Joint disease
Golden Retriever				x		Tumor and joint
Great Dane		x (but well beyond one year)				
Irish Wolfhound					x	Tumor
Jack Russell Terrier		x				
Labrador Retriever			x			Joint disease
Maltese		x				
Miniature Schnauzer		x				
Pomeranian		x				
Poodle (Toy)		x				
Poodle (Miniature)				x		Joint disease
Poodle (Standard)					x	Tumor
Pug		x				
Rottweiler				x		Joint disease
Saint Bernard		x (but well beyond one year)				
Shetland Sheepdog		x				
Shih Tzu		x				
West Highland White Terrier		x				
Yorkshire Terrier		x				

	Females					
Breed	**No neutering**	**Age of choice**	**> 6 months**	**> 1 year**	**> 2 years**	**Risk/Reason for delay**
Australian Cattle Dog			x			Joint disease
Australian Shepherd		x				Tumor
Beagle		x				
Bermese Mountain Dog		x				
Border Collie				x		Tumor
Boston Terrier		x				
Boxer					x	Tumor
Bulldog		x				Joint disease
Cavalier King Charles Spaniel		x				
Chihuahua		x				
Cocker Spaniel					x	Tumor
Collie				x		USMI and joint
Corgi (Welsh), Pembroke and Cardigan		x				
Dachshund		x				
Dobermann Pinscher					x	USMI and joint
English Springer Spaniel				x		USMI
German Shepherd					x	USMI and joint
Golden Retriever	x (or at one year)					Tumor
Great Dane		x (but well after one year)				
Irish Wolfhound		x (but well after one year)				
Jack Russell Terrier		x				
Labrador Retriever				x		Joint disease
Maltese		x				
Miniature Schnauzer		x				
Pomeranian		x				
Poodle (Toy)		x				
Poodle (Miniature)		x				
Poodle (Standard)		x				
Pug		x				
Rottweiler			x			Joint disease
Saint Bernard			x (ideally well beyond one year)			Joint disease
Shetland Sheepdog					x	USMI
Shih Tzu					x (or before 6 months)	Tumor
West Highland White Terrier		x (or after one year)				USMI
Yorkshire Terrier		x				

USMI: Urethral sphincter mechanism incompetence.

From Hart BL, *et al.* Decision-Making on Recommended Age of Spay/Neuter for a Specific Dog: General Principles and Cultural Complexities. *Vet. Clin. North Am. Small Anim. Pract.* 2023.

DIGESTIVE DISORDERS IN PUPPIES AND KITTENS

Digestive disorders are the most common reason for dogs and cats being presented to the veterinarian and are commonly observed in puppies and kittens.

Physiological reminders

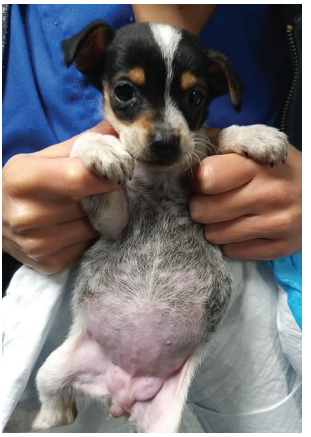


Figure 1. The picture shows a two-month-old puppy with large abdominal distension called potbelly due to roundworm infection.

Digestive disorders are mostly seen as diarrhea and/or vomiting, but other signs such as loose, liquid, or foamy stools, abdominal distension **(Figure 1),** and failure to thrive may also be consequences of digestive problems. These non-specific clinical signs can be variably severe and indicate physiological adaptation to new dietary experiences, but also may be signs of underlying diseases that require veterinary intervention. Application of best care practices *(i.e.,* hygiene, vaccination, deworming) as well as close observation of puppies and kittens is key in preventing a wide range of digestive disorders **(Table 1).** In young animals, the immune system and organ development are still ongoing and the recognition of organ malfunction such as in the liver and pancreas can be crucial for the survival of the animal. In addition, some congenital diseases such as cleft palate, megaesophagus, or portosystemic shunt will affect the animal after food intake and indicate digestive problems that may require surgical intervention.

Organ maturation is vital for efficient nutrient digestion. Although the salivary glands, pancreas, and gall bladder develop before birth, they are functionally immature at the time of birth. Digestive capabilities gradually increase over time and their development is stimulated by the food that puppies and kitten receive during and after weaning. Consequently, a highly digestible diet is very important to ensure that the young receive their full nutrient supply and develop to their best genetic potential. If maternal milk is lacking or absent, a scientifically formulated milk replacer is the best option to ensure adequate growth and development as well as functional health.

Diarrhea

Acute diarrhea may be a mild and self-limiting physical response to unfamiliar food or stress (see chapter "Weaning diarrhea"), but can also be associated with life-threatening acute gastroenteritis and/or infectious disease. Because of their small size, fluid and electrolyte losses in puppies and kittens with diarrhea can result in rapid dehydration and nutrient deprivation and requires timely intervention. Pet owners reporting the presence of watery, explosive, smelly, or bloody diarrhea should always be advised to come to the clinic. The puppy or kitten may also present with abdominal pain or be depressed, both alarming signs.

Appropriate housing, feeding, and deworming of the puppies and kittens and other household animals are key in minimizing the exposure of the puppy and kitten to pathogens. In addition, regular vaccination of the mother and adequate colostrum intake are crucial to maximize the maternal antibody transfer which will protect the puppy and kitten. Timely and regular vaccination of growing puppies and kittens to protect them once maternal antibodies have diminished prevents further infections and minimizes the clinical impact of pathogens.

Table 1. Most common preventable causes of (life-threatening) diarrhea in puppies and kittens.

Viral diseases	Bacterial diseases	Parasitic diseases
Canine distemper	*Campylobacter* spp.	Tapeworms: • *Dipylidium caninum* • *Taenia* spp.
Canine parvovirus	*Clostridium* spp.	Helminths: • *Ancylostoma* • *Strongyloides* • *Trichuris* • *Toxascaris/Toxocara*
Feline panleukopenia virus	Enterotoxigenic *E. coli*	Protozoans: • *Cryptosporidium* • *Giardia* • *Tritrichomonas* (cats)
Canine coronavirus	*Salmonella* spp.	Others: • *Isospora* • *Neorickettsia* • *Histoplasma* • *Prototheka*
Feline enteric coronavirus	*Yersinia* spp.	

Because most common causes of diarrhea are infectious, affected puppies and kittens should be isolated from the rest of the litter and the feces should be cleaned up promptly. Nutritional support and rehydration therapy are very important while awaiting a diagnostic outcome and subsequent treatment and can be administered orally or parenterally. The use of antibiotics is generally NOT recommended as many causes of diarrhea are not of bacterial but viral origin. Many bacterial species *(e.g., Campylobacter* spp., *Clostridium* spp., *Salmonella* spp.) are isolated from healthy puppies and kittens and are therefore not necessarily the causing agent. Furthermore, the use of antibiotics destroys the healthy gastrointestinal microbiota which negatively affects long-term intestinal health. Intestinal dysbiosis can result in ongoing, recurrent, and life-threatening diarrhea. It is therefore of great importance to foster a healthy intestinal microbiota and maintenance of the intestinal barrier. Because young animals do not have a solid, established intestinal microbiota, the consequences of its disruption due to antibiotic use can be assumed to be even more severe than in adults. Highly digestible diets, potentially enriched with psyllium, have been shown to resolve diarrhea. In dogs, recovery from diarrhea was faster with diet change alone while a diet change AND the administration of antibiotics resulted in a longer duration of diarrhea.

Because puppies and kittens explore their environment, they are at high risk of ingesting inedible or toxin-containing garbage material. While the ingestion of toxins usually causes a sudden onset of diarrhea, foreign body ingestion can also be characterized by gradually worsening diarrhea or vomiting with or without loss of general well-being.

Diet is one of the most powerful tools used to prevent and treat gastrointestinal disturbances as food is constantly in direct contact with the animal's intestinal barrier, microbiota, and immune system. Early dietary intervention can improve clinical outcomes and help to maintain the mucosal barrier integrity. In addition to being accurately formulated according to the life stage of the animal, the following dietary characteristics support gastrointestinal health:

- Diet composition: moderate to low fat, moderate protein, moderate carbohydrate.
- High quality nutrients: *e.g.,* highly digestible protein.
- Prebiotics: range of fibers to nourish the microbiota.
- Functional ingredients: *e.g.,* insoluble fibers, soluble fibers, omega-3 fatty acids, antioxidants.
- Some probiotics: *i.e.,* live micro-organisms with a demonstratable health benefit consumed in sufficient quantities.

Vomiting

Vomiting can be caused by a variety of disorders. It is important to distinguish vomiting from regurgitation (where no abdominal contraction is involved) and gastroesophageal reflux.

The act of vomiting is a reflex which usually includes prodromal signs such as behavior changes, salivation, and repeated swallowing attempts followed by active abdominal contractions. Food regurgitation by the mother for the puppies is a common caring function. This food is regurgitated shortly after ingestion and still has an aromatic food character. It is then re-ingested by the mother and/or puppies. The complications of pathologic vomiting may be mild or may require fluid treatment to address dehydration and/or restore the electrolyte balance. Vomiting can also affect general well-being more substantially and become life-threatening, for example if complicated by aspiration pneumonia.

Common causes of kitten and puppy vomiting include foreign body ingestion and motility disorders. Vomiting can also have an inflammatory origin in case of infections with viruses, bacteria, parasites, or garbage intoxication. To investigate the problem, a detailed history is important, including information about the frequency, severity, and appearance of the vomit. The timing of vomiting relative to the last food intake and the volume of the vomit are also important to note.

As with diarrhea, diet and early feeding are important in cases of vomiting. Feeding has been shown to decrease ileus which sometimes occurs in gastrointestinal conditions, and the prokinetic effect may help to decrease emesis.

Small frequent feeds are generally recommended to limit acid secretion and gastric distention, and foods that prolong gastric retention should be avoided *(e.g.,* high fat diets and diets with poorly digestible ingredients).

Regurgitation

The passive regurgitation of food, closely associated with food intake, is seen in puppies and kittens with megaesophagus. Problems of the muscular system of the esophagus and/or the gastric cardia result in problems transporting food into the stomach and its storage there.

While all puppies and kittens can be affected, Siamese and Siamese-related cat breeds, Great Danes, Irish Setters, Newfoundlands, German Shepherds, Shar Peis, and Labrador Retrievers have the highest incidence. The most common complication is aspiration pneumonia. Feeding animals with megaesophagus can be challenging as animals may respond differently to different food textures. The use of upright feeding protocols is an important aspect in managing of this disorder.

DERMATOLOGICAL DISORDERS IN PUPPIES AND KITTENS

The cutaneous barrier and hair coat of newborn cats and dogs consistently evolve from birth to six months of age. Skin thickness will progressively increase until tripled, while the fine early hairs called vellus will be replaced from 3-4 months of age onwards with thick, straight units. Up until 6 months of age, the skin pigments will give the coat its adult appearance.

Most congenital and hereditary skin disorders appear during the first 14-16 weeks of life.

The lifestyle of puppies and kittens contributes to the development of certain dermatoses associated with life in animal communities. The close physical contact between individuals, in combination with immune system immaturity, leads to a high prevalence of bacterial, viral, fungal, parasitic, and protozoal juvenile dermatoses.

While immune maturation progressively reduces the likelihood of infectious dermatosis, immune disorders such as hypersensitivity and autoimmune disease become more prevalent from 3 to 6 months of age onwards. Therefore, knowledge and understanding of the clinical characteristics of acquired and innate immune reactions are key points for the veterinarian to prevent, treat, and manage dermatoses.

Microbial and parasitic dermatitis in puppies and kittens

Bacterial dermatitis

Bacterial infections of young animals are mainly dominated by *Staphylococcus pseudintermedius*. The common presentation is an impetigo characterized by pustules in the epidermis. Kittens are rarely affected. Inflammation secondary to fecal and urine scalding or ectoparasitism increases the animal's susceptibility. Bathing with an antiseptic soap such as chlorhexidine is often sufficient to resolve this dermatitis.

Viral dermatitis

The most common viral dermatosis in young dogs is papillomatosis; kittens are rarely affected. Mucocutaneous viral papillomas, acquired by direct transmission, occur more often in the oral cavity but can also involve the lips, eyelids, and nasal planum. Lesions < 1 cm may be sessile or pedunculated. Many exophytic viral papillomas spontaneously regress over a period of weeks to months, otherwise cryotherapy is usually an effective treatment.

Fungal dermatitis

Puppy and kitten dermatophytoses are one of the most pleomorphic skin diseases due to the combination of an immature immune system, close skin contacts in the litter, warm and humid conditions in the kennel/cattery, and the animal's explorative behavior of the environment. *Microsporum canis* is the most commonly isolated organism. Classic lesions are a well circumscribed, non-pruritic, and slowly expanding circular alopecia affecting mostly the head, muzzle, pinnae, and distal limbs **(Figure 1).** Diagnosis is based on microscopic examination, hair fluorescence (50% of *M. canis)* under Wood's light (ultraviolet), and fungal culture of plucked hair. Topical and systemic antifungal applications as well as environmental antisepsis and management are effective treatment options.

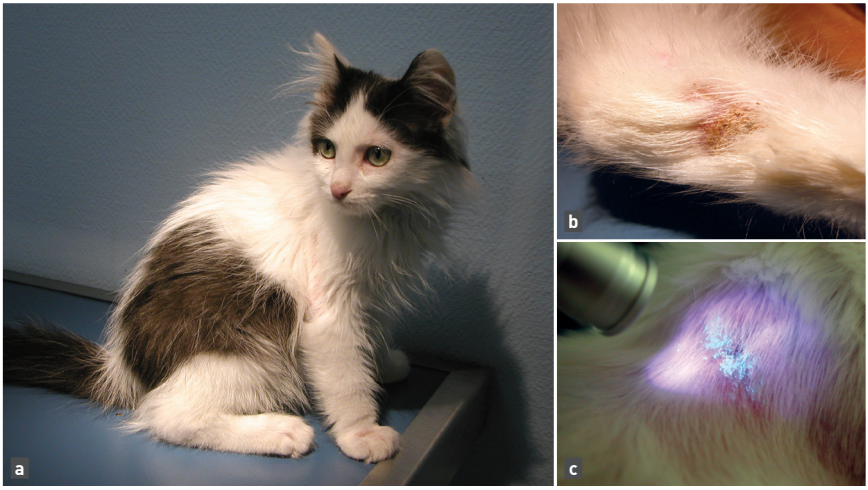


Figure 1. Dermatophytosis in a kitten **(a).** Erythema, alopecia, and crusts on the lateral metatarsus **(b).** Wood's light examination of alopecia of the lateral thorax reveals *Miscrosporum canis* fluorescence **(c).**

Parasitic dermatitis

Parasitic infestations (fleas, lice, and mites) are very common and usually acquired from the environment.

- Flea infestation is very frequent, and hypersensitivity to flea bites usually leads to severe pruritus followed by skin injuries and alopecia.
- In pediculosis, biting or sucking lice cause pruritic discomfort, progressive alopecia, and scaling. Lice and their eggs can be visible with the naked eye.
- Mites can be grouped as epicutaneous parasites (cheyletiellosis and *Otodectes* infestation), intraepidermic mites (sarcoptic mange), and species residing in pilosebaceous units (demodicosis).
  - Cheyletiellosis is characterized by a persistent pruritus, associated with mild scaling and/or crusting, and mild alopecia over the animal's back. The relatively large mites are easily recognizable under the microscope by their hooked mouth parts and their eggs attached to hairs.
  - *Otodectes* (ear mite) infestations of the ear are very frequent, contagious, and easy to recognize because of the intense pruritus and the abundance of parasites when investigating the black ear contents under the microscope.
  - Sarcoptic mange only affects dogs and is more subtle to diagnose as the skin lesions are variable. *Sarcoptes scabiei* var. *canis* is highly contagious and intensely pruritic. The mite lives mostly in the epidermis and the only visible primary lesion is the papule, a remnant mark of the mite's penetration. Lesions are mostly on the ventrum, crusted and with alopecic pinnal margins and excoriations cover mostly the lateral elbows. Deep skin scraping is necessary to reveal the mite and/or their eggs or feces. Treatment is based on antiparasitic drugs.
  - Demodicosis is a non-contagious parasitic skin disease caused by a mite which lives in/on healthy canine skin **(Figure 2).** This disease is rarely seen in cats. The mites reside in hair follicles and are transmitted to the new-born puppy by direct contact with the bitch during the first few days of life. Juvenile onset demodicosis may be localized or generalized, and the latter is potentially life-threatening. Localized demodicosis is characterized by one to five patchy alopecic areas concentrated on one body part. The vast majority of dogs experiencing localized demodicosis self-cure by 12-18 months of age. Under certain conditions (immunosuppression, high environmental load), local demodicosis can develop into its generalized form. Multifocal, erythematous, alopecic, and crusted macules and hyperpigmented and lichenified chronic lesions with secondary pyoderma are usually present on the head, trunk, legs, and paws of the dog. Diagnosis requires deep skin scraping. Antiparasitic treatment is required especially for generalized demodicosis until two negative skin scrapings at monthly intervals are obtained.

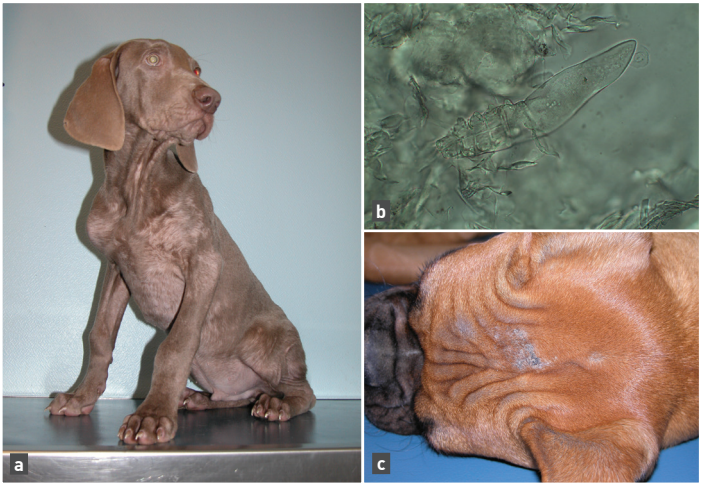


Figure 2. Alopecia of the head, trunk, and legs in a young Weimaraner (a). *Demodex canis* revealed by microscopic examination of skin scraping (b). Localized demodicosis in a young Boxer (c).

Congenital, hereditary, and acquired dermatologic defects in puppies and kittens

Focusing on the pilosebaceous unit, we describe congenital, hereditary, and acquired defects of the hair (alopecia) and the adnexa (keratoseborrhea):

Pattern alopecia

- Pattern baldness is a relatively common canine skin disease characterized by bilateral, symmetrical, and gradual hair loss. The Dachshund, Boston Terrier, Chihuahua, Whippet, and Italian Greyhound are predisposed to this non-inflammatory alopecia affecting the pinnae, the ventral neck, chest and abdomen, perianal area, and caudal thighs.
- Black hair follicular dysplasia, color dilution alopecia, follicular dysplasia, follicular lipidosis, melanoderma, and alopecia in Yorkshire Terriers can affect puppies.

Disorders of the surface and follicular epithelium

- Primary seborrhea in dogs is an inherited congenital disorder affecting skin keratinization, mainly recognized in American Cocker Spaniels, English Springer Spaniels, West Highland White Terriers, and Basset Hounds. Clinical signs occur early in life and intensify with advancing age and include ceruminous and hyperplastic otitis externa, greasy malodorous skin, excessive flaking of the skin, and coalescent scaly pruritic patches. More severe lesions affect the eyes, mouth, pinnae, interdigital areas, and axillar and inguinal areas. Diagnosis of primary seborrhea is made by exclusion diagnosis supported by biopsy histopathology. Treatment is based on topical management.

- Idiopathic facial dermatitis of Persian and Himalayan cats appears when cats are around 12 months of age **(Figure 3).** Lesions of the face affect the periocular, perioral, chin, and neck regions. Affected cats have a dirty, variably pruritic face. No effective treatment has been identified.

Figure 3. Idiopathic facial dermatitis in a Persian cat: erythema and alopecia of the periocular areas.

- Familial canine dermatomyositis is an idiopathic disease affecting the skin and muscles of young Collies, Shetland Sheepdogs, and Beauceron Shepherds. Skin lesions occur in areas of mechanical trauma, especially around the eyes and muzzle, the tips of the ears, digits, and tail. Skin lesions are non-pruritic, alopecic, and erythematous, with scaling and mild crusting. Myositis occurs months after the skin lesions, with masticator atrophy and megaesophagus.
- Footpad hyperkeratosis of Dogue de Bordeaux and Irish Terriers (sometimes Retrievers and Kerry Blue Terriers) occurs around 6 months of age.

Many other dermatoses can be mentioned in this chapter and should be considered in the differential diagnosis of juvenile dermatitis clinical cases such as: ichthyosis, epidermal dysplasia in West Highland White Terriers, nasal hyperkeratosis, epidermolysis bullosa, canine benign familial chronic pemphigus, and hereditary lupoid dermatosis of German Shorthaired Pointers.

Other juvenile dermatoses affecting collagen, elastin, blood vessels, hormone production, and/or the immune system include familial vasculopathy, lymphedema (also described in cats), acrodermatitis (Bull Terriers), cutaneous mucinosis (Shar-Pei), the Chiari-like malformation (Cavalier King Charles Spaniels), and urticaria pigmentosa (Sphinx cats).

Immune disorders in puppies and kittens

Hypersensitivity

Type I hypersensitivity is clinically characterized by urticaria and angioedema which are not specific to young animals but can affect puppies and kittens.

- Canine atopic dermatitis (CAD) is a Th2 modulated response, leading to a multifactorial inflammation in a skin barrier dysfunction context. Breeds predisposed to this pruritic dermatitis include West Highland White Terriers, French Bulldogs, Labrador Retrievers, Boxers, Dalmatians, Jack Russell Terriers, and Shar-Peis. Lesions are most commonly localized on the face (ears, lips, peripalpebral region), digits, and axillar/inguinal/perineal areas, with erythema and papules, and can progress to excoriations (pruritus), alopecia, lichenification, and hyperpigmentation **(Figure 4).** The diagnosis is based on Favrot's criteria **(Table 1)** targeting the clinical pattern in combination with the medical history. A rigorous diagnostic decision tree including an elimination/challenge diet trial will help lead to a diagnosis of CAD. Long-term management is based on a personalized multi-drug treatment, also targeting the multifactorial environmental etiology.
- Feline atopic skin syndrome (FASS) includes different clinical manifestations mediated by presumed allergic reactions. Similar to CAD, the onset is around 6 months of age and requires the same diagnostic and management approach.
  - Miliary dermatitis (pruritic small papules surrounded by crusts spread over the whole body).
  - Self-induced alopecia (pruritic alopecia of the lower abdomen following intense licking or biting).

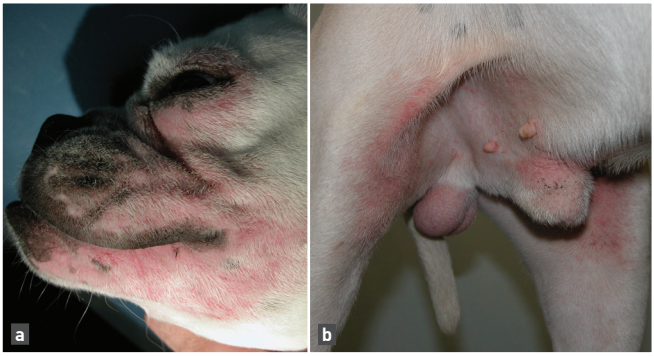


Figure 4. CAD lesions on the head of a French Bulldog, showing perioral erythema (a). Inguinal and perigenital erythema associated with CAD (b).

Table 1. Favrot's criteria.

	Use	Reliability
Set 1:		
1. Age at onset < 3 years 2. Mostly indoor 3. Corticosteroid-responsive pruritus 4. Chronic or recurrent yeast infections 5. Affected front feet 6. Affected ear pinnae 7. Non-affected ear margins 8. Non-affected dorso-lumber area	• Use for clinical studies and adapt required criteria based on the goal of the study • If higher specificity is required, 6 criteria should be fulfilled *(e.g.*, drug trials with potential side effects) • If higher sensitivity is required, 5 criteria should be fulfilled (*e.g.*, epidemiological studies)	• 5 criteria: Sens. 85.4% Spec. 79.1% • 6 criteria: Sens. 58.2% Spec. 88.5%
Set 2:		
1. Age at onset < 3 years 2. Mostly indoor 3. "Alesional" pruritus at onset 4. Affected front feet 5. Affected ear pinnae 6. Non-affected ear margins 7. Non-affected dorso-lumber area	• Use to evaluate the probability of the diagnosis of canine AD • 5 criteria should be fulfilled • Do not use alone for diagnosis of canine AD, and rule out resembling diseases	• 5 criteria: Sens. 77.2% Spec. 83% • 6 criteria: Sens. 42% Spec. 93.7%

From Hensel P, *et al.* Canine atopic dermatitis: Detailed guidelines for diagnosis and allergen identification. *BMC Vet. Res.* 2015.

- Face, head, or neck pruritus (intense pruritus of the cervico-cephalic region with large skin injuries following severe scratching).
- Eosinophilic granuloma complex **(Figure 5):**
  - indolent ulcer (focal non pruritic ulceration of the upper lips).
  - eosinophilic granuloma (typical linear thickening dermatitis on the caudal aspect of the limbs).
  - eosinophilic plaque (intensely pruritic well-demarcated eroded thick, often raised, lesions on the abdomen).

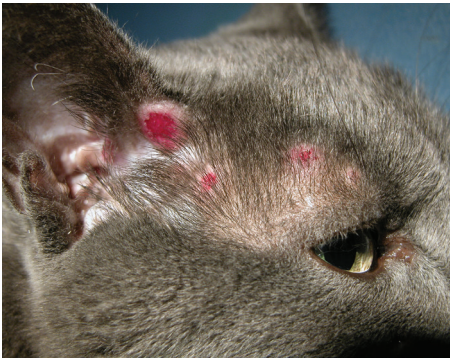


Figure 5. Eosinophilic granuloma complex on the head of a young cat.

Tumors in puppies and kittens

Histiocytoma

Histiocytomas are common benign tumors of dogs and a reactive proliferation or hyperplasia rather than a true neoplasm; 50% of affected dogs are under two years of age. Lesions are usually solitary, less than 3 cm in diameter, fast growing, and occur most commonly on the head, the pinnae, and the limbs. Cytologic examination is very suggestive, and the majority of histiocytomas undergo spontaneous regression within 3 months. Lesions that are causing problems such as pruritus, ulceration, or interdigital discomfort are treated with topical corticosteroids application or surgical excision.

CARDIAC DISEASES IN WEANED PUPPIES AND KITTENS

Cardiac diseases in young puppies and kittens fall into three categories: congenital abnormalities, early onset acquired diseases, and infectious diseases.

Physiological reminders and cardiac examination

The heart rate in puppies and kittens is estimated to be 20% faster than that of an adult: 70-180 beats per minute (bpm) for the puppy, 110-220 bpm for the kitten. Cardiac output, plasma volume, and central venous pressure are greater in young animals and gradually approach adult values by 7 months of life.

For auscultation, a pediatric stethoscope with the smallest bell and diaphragm is recommended. Although the small size of the patient makes it difficult to clearly localize heart sounds, the normal location of the valves is worth remembering:

- Pulmonic: left second to fourth intercostal space above the sternal border.
- Aortic: left third to fifth intercostal space at mid-thorax.
- Mitral: left fourth to sixth intercostal space just above the sternal border, the apex of the heart.
- Tricuspid: right sixth to seventh intercostal space at mid-thorax, the apex of the heart.

Ultrasound and doppler are invaluable tools in cardiology, but it may be useful to refer to a diagnostic imaging specialist. As there is a huge variation in size among puppies, a 5 MHz probe is a good compromise.

Congenital heart disease (CHD)

Congenital heart disease (CHD) occurs if malformations arise during embryonic development and persist after birth, resulting in morphological and functional changes of the heart or large vessels. The etiology of CHD in small animals is rarely known. Lesions may develop because of environmental, genetic, infectious,

toxic, nutritional, or drug-related factors. To date, mutations for tricuspid dysplasia and sub-aortic stenosis have been identified in the Labrador Retriever and Newfoundland breeds, respectively.

Despite CHD being present from birth, these lesions are not necessarily static, and clinical signs can manifest at a variety of ages. In cases with severe or complex disease, death *in utero* – or during the first few days/weeks of life may occur. This often occurs prior to veterinary assessment, and many of these abnormalities are therefore not seen clinically. The most common presentation of a kitten or puppy with CHD is the detection of a murmur on routine assessment of an asymptomatic pet during a health check **(Table 1).** For this reason, the most common age for diagnosis is in the post-weaning period. However, not all CHDs produce an audible murmur.

Additionally, nonpathologic murmurs – also known as innocent (*i.e.,* no structural abnormality) or functional *(i.e.,* physiological) murmurs – may be detected in young animals. They can be frequent in cases of stress, fever, or anemia, but may be inaudible if the animal is calm. These are typically soft, systolic murmurs located over the left heart base and are not accompanied by clinical signs of heart disease. However, the presence of a soft, left-sided murmur does not exclude CHD and therefore, unless echocardiography is performed, the cause of the murmur cannot be determined **(Table 2).**

Table 1. Grading murmur intensity.

Levine six-level scheme	Four-level scheme	Description
Grade I/VI	**Soft**	A soft murmur that is difficult to hear and is not immediately apparent
Grade II/VI		A soft murmur, quieter than the normal heart sounds, but can be detected immediately
Grade III/VI	**Moderate**	A moderate intensity murmur of similar Intensity to the normal heart sounds
Grade IV/VI	**Loud**	A loud murmur, louder than the normal heart sounds but a thrill cannot be palpated on the chest wall
Grade V/VI	**Thrilling**	A very loud murmur where a thrill is palpable but the murmur cannot be detected when the stethoscope is lifted off the chest wall
Grade VI/VI		A very loud murmur with a palpable thrill and the murmur is audible without a stethoscope or can still be heard when the stethoscope is lifted off the chest wall

Table 2. Presentation of the most prevalent congenital heart disease in small animals.

Defect	Suspected breed predisposition	Reported presentation
Ventricular septal defect	Pinscher, French Bulldog, German Shepherd, Terrier breeds	Asymptomatic; respiratory distress
Patent ductus arteriosus	German Shepherd, cross-breed, Newfoundland, Maltese, Doberman, Cavalier King Charles Spaniel, Dachshund, Chihuahua, Belgian Shepherd, Australian Shepherd, Poodle, Shetland Sheepdog, Border Collie, Yorkshire Terrier, Bichon Frise, Keeshond, American Cocker Spaniel, English Springer Spaniel, Rottweiler	Asymptomatic; respiratory distress; exercise intolerance; lethargy, retarded growth. Hyperkinetic pulses, jugular venous distension, and abdominal effusion have been reported
Tricuspid valve (TV) dysplasia	Chartreux cats Labrador Retriever, English Bulldog, Golden Retriever, German Shepherd dogs	Asymptomatic; respiratory distress; right-sided CHF; jugular distension/ pulsation, hepatomegaly, and ascites seen
Mitral valve (MV) dysplasia	Siamese cats (MV stenosis) Bull Terrier, Dachshund, Labrador Retriever, Yorkshire Terrier, Rottweiler, Golden Retriever, Newfoundland, Mastiff, German Shepherd dogs	Asymptomatic; respiratory distress
Aortic Stenosis	Siamese cats Boxer, Bull Terrier	Asymptomatic; dyspnea; syncope
Atrial Septal Defect	Chartreux cats Boxer	Asymptomatic; Cyanosis; Exercise Intolerance; Syncope; Dyspnea; Cough
Pulmonic Stenosis	Pedigree cats including Abyssinian, Devon Rex, and Siamese Dogs: Boxer, English Bulldog, French Bulldog, Pinscher, German Shepherd, Beagle, West Highland White Terrier, American Staffordshire Bull Terrier, Chihuahua, Pitbull Terrier, Yorkshire Terrier, Poodle, Standard Schnauzer, Mastiff, Samoyed, Miniature Schnauzer, American Cocker Spaniel, Keeshond	Cavity effusion associated with right-sided CHF

Non-exhaustive additional etiologies: atrioventricular septal defect, tetralogy of Fallot, subaortic stenosis, persistent right aortic arch, endocardial fibroelastosis, double outlet right ventricle, cor triatriatum sinister, cor triatriatum dexter, pericardial peritoneal diaphragmatic hernia, double chamber right ventricle.

Murmur type	Treatment options
Systolic murmur; wide radiation with PMI right hemithorax; in dogs, split second heart sound is described in some cases.	Many cases do not require therapy; if CHF, medical management *(i.e.,* diuretic therapy) or referral surgical options might be available (pulmonary artery banding; transcatheter occlusion devices).
Majority: Continuous machinery murmur at the dorsal left heart base; one third of cats and occasionally dogs: systolic murmur only.	Medical management for CHF may be required. If pulmonary hypertension is present, phosphodiesterase-V inhibition may be warranted. Referral surgical options might be available (surgical ligation or transcatheter occlusion).
Systolic murmur; wide radiation with PMI right hemithorax; in dogs, split second heart sound is described in some cases. TV Stenosis: diastolic right apical murmur present.	Medical management of CHF; catheter-based surgical interventions might be a consideration.
MV regurgitation; systolic murmur left apical (dog) or along the left parasternal border (cat). Gallop sounds reported in the cat. MV stenosis: none or subtle diastolic.	If CHF, medical management; MV stenosis: Beta-blockade may be useful if not CHF. Catheter-based surgical interventions for MV stenosis might be a consideration.
Loud systolic murmur; PMI left/ parasternal; gallop sounds reported in cats. In dogs, split second heart sound is described in some cases.	Medical management of CHF, treatment with thromboprophylaxis if LA dilation; consider dysrhythmics. In dogs, surgical valvuloplasty has been reported.
None to moderate systolic murmur; PMI left heart base. In dogs, split second heart sound is described.	Catheter-based interventions, open-heart surgery, or medical management.
Loud, systolic, PMI left basilar right hemi-thorax (right apex) described in some cats. In dogs, split second heart sound is described in some cases.	Medical management and paracentesis. Medical therapeutics may include thromboprophylaxis, beta-blockage (if no CHF present). Balloon valvuloplasty has been performed in cases with stenosis. Prognosis fair (poor if CHF is present).

PMI – point of maximum intensity, CHF – congestive heart failure, TV – tricuspid valve, MV – mitral valve, LA – left atrium.

Several non-cardiac congenital diseases can affect the myocardium:

- Congenital hypothyroidism, linked to decreased myocardial contractility and low or low-normal blood pressure, accompanied by stunting (classically disproportionate dwarfism), dull mental state, and weight gain. These cases are relatively easy to identify and rarely present with clinical signs of cardiac dysfunction.
- Various forms of muscular dystrophy can manifest at an early age; however, these cases often present with poor suckling, weakness, and a failure to thrive, without overt signs of cardiac disease.

Dilated cardiomyopathy is a primary disease of the heart muscle of unknown etiology but also as a consequence of toxins, nutritional deficiencies, endocrinopathies, and infectious agents (so-called "secondary cardiomyopathy"). Clinical signs appear later in life, but the condition is suspected to cause sudden death in young dogs and cats.

Early-onset acquired diseases

Cardiomyopathies are considered diseases of adult cats and dogs. However, kittens with hypertrophic cardiomyopathy (HCM) have been reported to demonstrate hypertrophy and clinical signs from 8 weeks of age. Restrictive cardiomyopathy (RCM) has been reported in cats as young as 4 months of age. This form of cardiac disease remains poorly understood, although links to several infectious diseases have been proposed.

In dogs, juvenile forms of dilated cardiomyopathy (DCM) are recognized in the Portuguese Water Dog and Doberman Pinscher breeds. In the Portuguese Water Dog, affected puppies typically die before 7 months of age (some with sudden death, others presenting with rapid onset congestive heart failure). Similarly, in the Doberman Pinscher, congestive heart failure affects puppies between 10 days and 17 weeks of age. With puppies in both breeds, the disease appears refractory to treatment.

Some breeds of dog have been recognized as developing early onset arrhythmia. Referral to a cardiologist for holter assessment is advised in those affected but these diseases are associated with sudden death in some cases.

Infectious cardiac diseases

Do not forget to consider trauma, heat stroke, carbon monoxide poisoning, envenomation, or poisoning *(e.g.,* puppy eating the owner's medicine or chocolate). Although extremely rare, some neoplasia *(e.g.,* lymphoma) may affect the heart, even early in life.

Many viruses, bacteria, fungi, or parasites have a deleterious effect on cardiac function either directly or via the toxins they release. An infection can happen *in utero* or earlier in life. Infectious causes of cardiac disease are not uncommon in post-weaning puppies and are occasionally reported in kittens. In dogs, canine parvovirus-2 (CPV-2) is a recognized cause of myocarditis, with a median age of two months in the affected population. Canine distemper virus (CDV) can also lead to myocarditis, with puppies dying between 4 and 7 weeks of age.

While there are few studies which have identified other viruses within the myocardium, several other diseases have been noted such as *Dirofilaria immitis*, *Neospora caninum, Toxoplasma gondii, Borrelia burgdorferi, Citrobacter koseri, Salmonella Dublin,* or *Clostridium piliforme* (Tyzzer's disease).

Unfortunately, there are few reports of pre-mortem diagnosis of infectious myocarditis in puppies and kittens. The disease course is often rapid (frequently only a few hours), leaving little time for diagnostics or treatment. However, obtaining a definitive (post-mortem) diagnosis may be beneficial in deciding treatment for siblings.

Nutritional deficiencies

Taurine deficiency has been identified as a cause of cardiomyopathy in both dogs and cats. The dietary regime of the pregnant bitch/queen is of course extremely important. An increased incidence of dilated cardiomyopathy later in life in dogs fed commercial "grain-free" or home-made diets has been described. Practitioners should check the food given and warn the owner about the risks involved. If suspected, the plasma taurine concentration should be measured (the deficiency cut-off point is < 50 nmol/mL of plasma).

RESPIRATORY DISEASES IN WEANED PUPPIES AND KITTENS

Puppies and kittens can be affected by a wide range of respiratory conditions affecting the upper and/or lower respiratory tract. There are several congenital and inherited traits that can affect the respiratory system, many of which may not become evident until the post-weaning period. The respiratory tract is an internal space which is continuously exposed to the external environment (therefore a frequent site for external pathogens) and is often involved in systemic disease, with the development of acute respiratory distress in critical patients.

Nasal diseases in weaned puppies and kittens

- Infectious
  - Viral infections: in kittens, feline upper respiratory tract infection complex (feline herpesvirus – FHV; feline calicivirus – FCV). In puppies, canine parainfluenza (CPI), canine herpes (CHV), canine distemper virus (CDV), canine adenovirus 1 & 2).
  - Bacterial infections: secondary infection *(e.g.,* following invasion from the oropharynx, foreign bodies, neoplasia, trauma or immune suppression), *Bordetella bronchiseptica, Mycoplasma* spp.
  - Fungal infections: *Aspergillus fumigatus, Cryptococcus neoformans.*

This chapter is complementary to the chapters "Respiratory disorders in unweaned kittens" and "Canine infectious respiratory disease complex."

- Inflammatory
  - Post-viral rhinitis/chronic idiopathic rhinitis (typically adult onset).
  - Allergic rhinitis (typically adult onset).
  - Lymphoplasmacytic rhinitis (typically adult onset).
  - Nasal or nasopharyngeal polyps.
  - Nasopharyngeal stenosis.
  - Parasitic rhinitis.
- Oral disease: palatine defects, periapical infections of the maxillary teeth, tooth root abscessation.
- Trauma, foreign body.

Diagnostic approach

Once a thorough history and physical examination have been obtained, it is important to rule out systemic causes prior to continuing with a nasal work-up. Routine hematology (including a platelet count), biochemistry, a coagulation profile, and FeLV/FIV status (in cats) should be assessed. In addition, in cases of suspected infection, swabs should be taken from the oropharynx or conjunctiva and sent in special transport media for analysis. Swabs for bacterial culture should demonstrate a pure, heavy growth of a potentially pathogenic organism to be considered significant. Serology for *Aspergillus* species should be confirmed by culture, cytology, or biopsy.

Diagnostic imaging

Radiographic evaluation should include a minimum of two orthogonal views. Evaluation should include assessment of symmetry, bone and turbinate definition, variations in opacity, and soft tissue changes.

Computed tomography (CT) provides better resolution and is more sensitive than radiography. CT provides better resolution of areas such as the cribriform plate and nasal turbinates and is useful in the early detection of soft tissue masses; note that epistaxis and nasal discharge can be hard to differentiate from soft tissue opacities when viewing scans.

Rhinoscopy and pharyngoscopy are useful techniques to directly evaluate lesions, biopsy samples under visual guidance, and the identification and removal of foreign bodies within the nasal and pharyngeal regions. It is important to have

assessed the patient's coagulation status and to have thoroughly packed the nasopharynx prior to performing this procedure.

Retracting the soft palate is important to ensure that there are no foreign bodies, tumors, or polyps within the caudal nasopharynx.

Nasal biopsies can be obtained by endoscopic guidance or by blind biopsy. Care should be taken not to penetrate the cribriform plate; the medial canthus of the eye is generally considered the maximum distance to penetrate the nasal cavity.

Treatment of nasal disease should be aimed at identifying and treating the underlying condition. However, olfactory impairment can lead to anorexia and animals may require supportive treatment. Humidification of the environment or heating of food may resolve this problem. In extreme cases, tube feeding or even parenteral nutrition may be required.

Brachycephalic obstructive airway syndrome (BOAS)

Most commonly, excess soft palate is evident in combination with stenosis of the nares, eversion of the laryngeal saccules, and hypoplasia of the trachea in some cases.

Clinical signs

Upper airway obstruction, with signs of snoring, syncope, cyanosis during exercise, or collapse during eating is frequently reported. A pharyngeal stertor may be auscultated and may be associated with a pronounced sinus arrhythmia. Brachycephalic dogs compensate for their malformations by "pulling" harder when they breathe in. This creates strong negative pressures in their throat, neck, and chest, which in turn eventually causes secondary respiratory and digestive diseases. This is one of the reasons why brachycephalic dogs frequently regurgitate or vomit.

Diagnosis

Lateral radiographs of the head and neck may demonstrate a long soft palate and/or hypoplasia of the trachea. Pharyngoscopy and laryngoscopy provide a definitive diagnosis and assessment of the soft palate and laryngeal saccules. "Belly-wrapped" conscious CT is preferred for the diagnosis of concurrent hiatal hernia instead of fluoroscopic examination.

Treatment

The mainstay of treatment is surgical correction of stenotic nares and resection of excess tissue of the soft palate and laryngeal saccules where necessary. In many

cases, concurrent bronchopneumonia may be present and require treatment. In addition, treatment of reflux esophagitis with antacids (omeprazole or ranitidine) can improve the clinical signs. In general, the outcome with surgical intervention is excellent, although some dogs will continue to regurgitate. Medically, this can be successfully managed by feeding at an angle of 30 degrees or more *(e.g.,* standing on a step), feeding frequent small meals, and using antacids as necessary.

Primary ciliary dyskinesia

This is a rare inherited defect of microtubule formation affecting cilia within the respiratory and urogenital tract and the auditory canal. It can also occur secondary to chronic respiratory disease. The congenital disease is an autosomal recessive trait that may be associated with *situs inversus*, known as Kartagener's syndrome. The syndrome results in infertility in males (partial in females), loss of hearing, hydrocephalus, renal disease, and abnormalities of the sternum, ribs, and vertebrae. Expression of the mutation may be partial or complete creating various degrees of severity. Affected breeds include the Newfoundland, Bichon Frise, Old English Sheepdog, English Springer Spaniel, Golden Retriever, English Pointer, Gordon Setter, English Setter, Rottweiler, Doberman.

Clinical signs

Chronic rhinitis, chronic bronchitis, bronchopneumonia, deafness and/or sterility (or partial sterility) may be evident. Physical examination often reveals a moist cough, chronic sinus problems, coarse rales, increased tracheal sensitivity, noisy breathing, bronchopneumonia, pyrexia, malaise and nasal discharge.

Lower respiratory tract disease

Bacterial pneumonia most commonly affects the right middle, right cranial, and caudal portion of the left cranial lung lobes and typically involves a mixed bacterial growth: *Mycoplasma, Mycobacteria, Pasteurella, Streptococcus, Bordetella, E. Coli, Pseudomonas,* and the group eugonic fermenter-4 (EF-4a) bacteria. The choice of antibiotics may depend on the results of the culture and sensitivity in stable cases. However, in severe cases, antibiotic therapy may be commenced without a definitive diagnosis. Broad spectrum cover is recommended, which can be achieved by various combinations of antibiotics.

Diagnostic imaging is essential for the evaluation of cats with pneumonia, revealing a variety of possible radiographic patterns. Bronchopneumonia may present as a diffuse broncho-interstitial pattern, with or without localized areas of alveolar consolidation. A multifocal distribution of patchy alveolar infiltrate can occur, which may not be readily distinguishable from metastatic disease. In severe cases, pleural effusions may also be present.

Assessment of serum biochemistry and hematology (and FIV/FeLV in cats over 6 months of age) can be useful in obtaining an overall picture of the pet's health and assessing its suitability for general anesthesia. In addition, a series of fecal samples should be collected and submitted for Baermann flotation for the detection of lungworm. However, in practice it is often more convenient to perform a clinical trial using fenbendazole (50 mg/kg q24h PO for 10 days).

In many cases, a diagnosis of bronchopneumonia is based on the history and clinical signs supported by radiographic changes. However, it is important to recognize the limitations of this approach. Radiographic evidence of alveolar infiltration prompts a long list of differentials including pulmonary edema, thromboembolic disease, pulmonary hemorrhage, neoplasia, and atelectasis.

In larger puppies and kittens, bronchoscopy can be useful in assessing the trachea and main stem bronchi.

Bronchoalveolar lavage (BAL) can be achieved using a bronchoscope or without endoscopic guidance. Once obtained, the BAL fluid should be assessed for cytology and culture, and PCR should potentially be performed for *Bordatella bronchiseptica* and/or *Mycoplasma* species.

Oxygen supplementation should be provided if the SpO_2 is less than 94% (or if the PaO_2 is less than 80 mmHg). Humidification of administered oxygen is essential to maintain the mucociliary escalator and facilitate the coughing of secretions.

Intravenous fluids are often indicated as animals with pneumonia may be inappetent. In addition, dehydration may change mucus composition, decreasing mucociliary clearance and alveolar emptying. Inappetent cases may also benefit from supplemental feeding, either by parenteral nutrition, a naso-esophageal, or an esophagostomy tube.

Atelectasis can exacerbate respiratory insufficiency. Recumbent patients should therefore be turned every 1-2 hours, or ideally supported in sternal recumbency. Nebulization can help hydrate the mucocilary system and encourage coughing.

Except pneumonia, lower respiratory tract disease can also be caused by foreign bodies, pulmonary contusions, pulmonary edema, or pulmonary fibrosis.

Others pathogens

- Viral: avian influenza H5N1 (rare), canine distemper virus, canine herpesvirus, canine infectious hepatitis, canine influenza (H3N8 virus), canine parainfluenza, canine respiratory coronavirus, feline calicivirus, feline herpesvirus, feline infectious peritonitis, pox viral infection (especially cats).
- Fungal: various.
- Parasitic: toxoplasmosis, verminous.
- Lipoid/reactive.

Pleural and extra-pleural diseases

Pyothorax: this is a bacterial infection of the pleural space which is commonly associated with pyrexia and coughing. Diagnosis is based on fluid analysis: protein count > 30 g/L, specific gravity (SG > 1.025), and nucleated cell count > 3,000 cells/µL with the predominant cell type being degenerate neutrophils. Treatment is typically achieved via a combination of drainage and antibiotics (often a combination of metronidazole and amoxicillin clavulanate is used while awaiting the results of culture).

Non-septic exudate: non-septic exudate has a high in protein content (SG > 1.025) and a high cell count, but there is no suggestion of bacteria or infectious agents. This form of effusion can be seen secondary to inflammatory diseases.

Hemorrhagic effusion: trauma, coagulopathy, neoplasia, lung lobe torsion, *Spirocerca lupi* or *Dirofilaria immitis,* pulmonary infarction, and involution of the thymus can all result in a hemorrhagic pleural effusion.

Modified transudate: the protein of a modified transudate is usually between 25 g/L and 50 g/L. The cell counts may vary from 500 cells to 8,000 cells/µL, with a majority of cells being either macrophages, lymphocytes, or a combination of the two. There are many causes of a modified transudate, including congestive heart failure, neoplasia, diaphragmatic hernia, or peritoneal-pericardial hernia, lung atelectasis, or torsion of an organ such as a loop of intestine (which can progress to become a non-septic exudate).

Chylothorax: chylothorax is caused by diseases that cause obstruction or rupture of the thoracic duct, which increase lymphatic flow or impair lymphatic to venous flow.

Differential diagnosis includes idiopathic (Afghan Hounds, Shiba Inu, Oriental cats), neoplastic (see "Mediastinal disease" below), fungal disease, heart disease, lung lobe torsion, and trauma.

Triglyceride levels in the fluid are greater than in plasma, the cholesterol: triglyceride ratio of fluid is < 1 and chylomicrons may be seen microscopically. Conservative management can be done with repeated drainage, otherwise surgical management is possible.

Pure transudate: uncommon form of effusion in which fluid (low protein concentrations and cell counts) leaks from the blood vessels due to either low albumin or increased portal pressure.

Mediastinal disease

The carina is normally located at the 5-6th intercostal space in dogs (6th in cats) on lateral radiography. Displacement implies that a soft tissue structure is present within the mediastinum. Mediastinal disease can occur with trauma (most common), infection/inflammation, neoplasia, or secondary to a foreign body.

Clinical signs of mediastinal disease are usually associated with pressure on the structures within the mediastinum and can involve one or more of the following: respiratory signs, laryngeal paralysis, esophageal or gastrointestinal signs (regurgitation, dysphagia), Horner's syndrome, vena cava syndrome (head and forelimb edema), right-sided cardiac failure (pericardio-diaphragmatic hernia), or cardiac dysrhythmia.

Imaging the mediastinum is best performed by CT, although radiography can be used. In addition, fluid or masses may be evident on ultrasonography. CT or ultrasound-guided aspirates can be performed in order to aid diagnosis, although some cases require surgical biopsy.

In young animals, the mediastinum may appear wide, but this may be due to the normal size and shape of the juvenile thymus. If CT or radiography demonstrates mediastinal widening, the location of this widening can help to formulate a differential diagnosis list: cranial mediastinal widening (mediastinitis, edema, hemorrhage, abscessation, granuloma, lymphadenopathy, neoplasia, fat), or caudal widening beyond level of heart base (congenital pericardio-diaphragmatic hernia, gastrointestinal conditions, *e.g.,* hiatal hernia, megaesophagus).

NEUROLOGICAL DISORDERS IN WEANED PUPPIES AND KITTENS

The nervous system collects and integrates sensory information, formulates a response, and initiates a motor output. When confronted with neurological signs, it is important to bear in mind the numerous interactions and possible collateral damage. At three months old, the sensory abilities of the puppy/kitten are fully developed. The sensory reflexes are identical to those of the adult and the neurological examination can be interpreted in the same way.

Clinical signs and diagnosis

Clinical signs

These are highly variable and the diversity of clinical signs mirrors the complexity of the nervous system and its various functions. Head tilt, tremor, ataxia, paresis, seizures, and coma are only a few common signs of neurological diseases. However, certain neurological signs are not caused by lesions of the central or peripheral nervous system *(e.g.*, middle ear disease, hepatic encephalopathy, hypoglycemia, or cardiovascular disease).

History

Careful history taking is mandatory since some neurological diseases may arise from previous events, including *in utero (e.g.,* griseofulvin treatment in pregnant cats).

Nutrition, potential exposure to infectious agents, toxic substances, or trauma must be evaluated to reach the diagnosis and implement the right treatment as soon as possible to prevent long-term sequelae.

Depending on the condition, the animal might be able to compensate, and with some adaptations by the pet owner, it can have a good quality of life.

Standard neurological examination

This first-opinion clinical examination aims to answer these four questions:

1. Are the clinical signs observed caused by a nervous system lesion?
2. What is the location of the lesion within the nervous system?
3. What are the main types of disease processes that can explain the clinical signs?
4. How severe is the disease?

Neurological examination

Hands-off examination:

- Mental status and behavior
- Posture and body position at rest
- Evaluation of gait
- Identification of abnormal involuntary movements

Hands-on examination:

- Cranial nerve assessment
- Postural reaction testing
- Spinal reflexes, muscle tone and size
- Sensory evaluation

Subsequently, certain specific neurological tests should be performed. Diagnostic imaging and functional tests (electrophysiology) will be next in the diagnostic workup. Standard blood and urine tests are always useful. Cerebrospinal fluid analysis may be indicated although the risks linked to collection are far from negligeable.

Nervous system diseases can be classified according to their etiology using a mnemonic acronym: **DAMNITV** (Degenerative, Anomalous, Metabolic, Neoplastic, Nutritional, Inflammatory, Infectious, Idiopathic, Traumatic, Toxic, Vascular). Some of these are less prevalent during the initial months of life (Degenerative, Neoplastic).

Congenital neurological conditions

These can be – but are not always – hereditary (genetic) and numerous systems/functions may be affected to cause neurological signs: central and peripheral nervous systems, hepatic disease (porto-systemic shunt), coagulation disorders (von Willebrand's disease), hypothyroidism, and hyperadrenocorticism (rare in puppies and kittens). Several genetic tests are now available to support diagnosis.

The list of breeds presenting neurological diseases is extensive and it is almost impossible to be exhaustive. Among them:

- Neural tube closure defects/spina bifida: English Bulldogs, Manx cats.
- Dermoid sinus: Rhodesian Ridgeback.
- Degenerative encephalopathy: Nova Scotia Duck Tolling Retriever.
- Myasthenia gravis: Jack Russell Terrier, Abyssinian cat.
- Deafness: Dalmatian, white cats with blue eyes.
- Strabismus: Siamese cat.
- Epilepsy: Dalmatian.
- Hydrocephalus: especially in toy and brachycephalic breeds such as Pugs, Bulldogs, Bull Mastiffs, and Chihuahua.
- Lissencephaly: Lhasa Apso.
- Syringomyelia: Cavalier King Charles Spaniel.
- Polyneuropathy: Bengal cat.
- Intervertebral disc disease: British Shorthair, French Bulldog.
- Pendular nystagmus: various breeds of Asian cats.
- Congenital vestibular disease: German Shepherd, English Cocker Spaniel, and Doberman Pinscher.

Puppies and kittens of the same litter share more than their genetics. If several individuals of a litter present with the same neurological signs, infectious diseases, nutritional deficiencies, and toxicities should be ruled out before blaming the DNA.

Acquired neurological conditions

- **Degenerative**

Examples include spongiform degenerative conditions in Egyptian Mau and Burmese kittens. The animals show incoordination, an abnormal gait, head tremors, muscle contractions, and behavioral changes. The etiology is unknown and the prognosis is poor.

- **Metabolic and nutritional origins**

Acute polyradiculoneuritis is a rare but debilitating condition that causes weakness in the hind legs, which may progress to the front legs, neck, head, and face. Affected dogs can have decreased reflexes, muscle tone, and muscle mass. If the chest muscles are involved, it can cause labored breathing. In extreme cases, some dogs may die from respiratory paralysis, but most recover fully without treatment, although it can take up to six months or more. An increased risk of developing acute polyradiculoneuritis has been linked to the consumption of raw chicken meat (due to *Campylobacter/Clostridia* infection), but has also been associated with toxoplasmosis, autoimmune disease, and vaccination.

Other nutritional imbalances causing neurological troubles include hypocalcemia, thiamine deficiency (all-fish diet), improperly processed or stored dry food, taurine deficiency (kittens), and vitamin E deficiency (rare but must be considered for puppies and kittens fed "home-made" diets).

Metabolic causes include steroid myopathy, Cushing's myopathy, and hypothyroidism.

Puppy hypoglycemia is seen in toy breeds in the first six months of life. The condition usually disappears as the animal matures and can be managed by feeding frequent meals.

- **Infectious origin**

Infectious diseases of the nervous system are more likely in puppies and kittens compared with adults.

In cats:

Naturally occurring infectious causes of CNS disease in domestic cats

Viral

- Feline coronavirus (FCoV)
- Feline immunodeficiency virus (FIV)
- Feline leukemia virus (FeLV)
- Feline panleukopenia virus (FPV)
- Rabies virus
- Aujeszky's disease virus
- Feline herpesvirus-1 (FHV-1)
- Borma disease virus (BDV)
- Certain arboviruses

Fungal

- *Cryptococcus* species
- *Blastomyces* species
- *Histoplasma* species
- *Aspergillus* species
- Dematiaceous fungi

Rickettsial

- *Ehrlichia* species

Protozoal

- *Toxoplasma gondii*

Bacterial

- *Pasteurella* species
- *Staphylococcus* species
- Other aerobic organisms
- Anaerobic organisms
- Mycobacteria
- *Bartonella henselae* and related species

Parasitic

- *Cuterebra* larval migration
- Visceral larva migrans *(e.g., Toxocara)*
- *Sarcocystis* species
- *Dirofilaria immitus*

Probable and other

- Feline polioencephalomyelitis and miscellaneous viral non-FIP encephalitides*
- Feline spongiform encephalopathy (FSE)

The most common causes of encephalitis in cats are indicated in red; others are sporadic and rare.
*Also termed non-suppurative (meningo)encephalitides (of unknown cause)

Adapted from Gunn-Moore DA and Reed N. CNS Disease in the Cat: Current Knowledge of Infectious Causes. *J. Feline Med. Surg.* 2011.

Kittens exposed to feline panleukopenia *in utero* may develop cerebellar hypoplasia. Magnetic resonance imaging (MRI) is used to diagnose the disorder. The kitten typically has a tremor that does not worsen as the cat matures and does not prevent the animal from having a good quality of life.

Rabies is always fatal and is a zoonosis. Vaccination is recommended and is mandatory in many countries. It is critical to inform pet owners about this disease.

In dogs:

Naturally occurring infectious causes of CNS disease in domestic dogs

Viral

- Distemper
- Canine herpesvirus
- Parvovirus type 2
- Adenovirus type 1
- Parainfluenza virus
- Aujeszky's disease
- Rabies

Fungal

- Cryptococcosis
- Phaeohyphomycosis
- Aspergillosis
- Blastomycosis
- Histoplasmosis

Bacterial

- Directly or via toxins *(Clostridium botulinum, Clostridium tetani)*

Protozoal

- *Neospora caninum*

Rickettsia

- *Ehrlichia*
- *Rickettsia*

Parasitic

- Aberrant migration of *Angiostrongylus vasorum*
- *Dirofilaria immitis*
- *Cuterebra*
- *Taenia*
- *Toxascaris*
- *Ancylostoma*

Algae

- *Prototheca*

Arthropod-borne diseases

- "Tick paralysis"

- **Toxic**

Endogenous intoxication includes hypoxia, hypoglycemia, hyperglycemia, uremic encephalopathy, or hepatic encephalopathy (HE). In HE, clinical signs include "staring into space," excessive drooling, inappropriate vocalization (meowing, crying, barking), aggressive behavior, and restnessless. In advanced disease, depression, blindness, sudden jerking motions, stupor, coma, or seizures can be seen. Signs are usually noticed before the animal is six months old. Hepatic encephalopathy is diagnosed using imaging techniques such as computed tomography or ultrasonography. Blood tests may aid in diagnosis.

External intoxication can be caused by chemicals including pesticides, rodenticides, herbicides, fungicides, heavy metals, drugs, venomous substances (snake bite, toad, ticks), plants, mycotoxins, antifreeze, detergents, and disinfectants.

- **Vascular: idiopathic fibrocartilaginous embolism (acute onset)**

Blood vessel obstruction caused by the migration of fibrocartilaginous nucleus pulposus material from an intervertebral disc into an artery or vein, provoking spinal cord ischemia.

OSTEOARTICULAR DISORDERS IN WEANED PUPPIES AND KITTENS

Together with the muscles, the bones and joints are as important as any other body system. They must be in full working order to permit the prehension of food, crouching for elimination, and, of course locomotion. While an appropriate diet may help prevent some osteoarticular disorders during the growing phase, congenital (hereditary or not) or acquired (numerous causes including trauma, toxicity, infectious, and metabolic diseases) can affect puppies' and kittens' development.

Physiological reminders

Large breed dogs have a longer growth period than smaller dogs and bone/joint articulation may therefore be more susceptible to environmental and exogenous perturbations.

Though they are generally less mineralized in puppies and kittens compared to adults, bones may appear radiologically irregular before two months of age, especially in the active remodeling sites (metaphyses). A radiolucent line is visible between the metaphysis and epiphysis and may mimic a fracture line or joint space. These lines will reduce during growth until the epiphysis and metaphysis fuse to form a radiopaque scar.

Joints allow movement and serve as shock absorbers. Radiographically, the cartilage appears as soft tissue with the same opacity as the synovial fluid and the joint capsule making the joint spaces appear larger in the young animal than they are in reality. If there is any doubt about soft tissue opacity on radiographs, consideration should be given to radiographing the opposite limb for comparison.

Due to the diversity between dog breeds, litters, and individuals, it is very difficult to establish a table of reference values for all bone data **(Table 1).** Ideally, when images are taken of limbs, they should be compared with the opposite limb and the images should be kept for monitoring between examinations.

Table 1. Reference age of onset and closure of the different ossification sites of the puppy.

Bones	Appearance (in weeks)	Closure (in months)
Supraglenoid tubercle	6-9	4-7
Humerus		
• Proximal epiphysis	1-2	10-13
• Distal epiphysis	2-4	5-8
• Medial epicondylei	6-9	4-8
Radius		
• Proximal epiphysis	3-5	6-11
• Medial epiphysis	2-4	8-10
Ulna		
• Olecranon	7-9	7-9
• Distal epiphysis	7-8	8-10
Carpal bones		
• Accessory	7-11	3-5
• Radial/Intermediate	3/2-3	3-4/3-4
• Central/Ulnar	4-6/4-6	3-4/3-4
Metacarpus		
• Proximal epiphysis	3-5	5-6
• Distal epiphysis	3-4	6-7
Phalanges		
• Promixal	5-6	6-7
• Distal	5-7	5-7
Femur		
• Femoral head	2-3	6-10
• Greater trochanter	4-10	8-11
• Distal epiphysis	3-4	9-11
• Appearance of the patella	8-9	–
Tibia		
• Proximal epiphysis	2-5	10-13
• Tibial tuberosity	7-9	6-8
• Distal epiphysis	2-6	8-9
• Fusion of the tibial tuberosity and proximal epiphysis	–	8
Fibula		
• Proximal epiphysis	9-10	8-11
Tarsal bones		
• Talus and Calcaneus	1	–
• Calcaneal tuberosity	5-6	5-7
Ilium	At birth	4-6
• Iliac crest	4-7	12-30
Pubis	At birth	4-6
Ischium	At birth	4-5
• Ischial tuberosity	3-5	8-10
Acetabulum	1-2	3-5
Pelvic symphysis	–	3-13 years
Closure of the spine	–	7-8

Clinical signs and diagnosis

Depending on the osteoarticular problem, the clinical signs may vary considerably and include pain (expressed during manipulation, contact, or when moving), swelling, gait abnormalities, soft tissue changes around joints, or other non-specific signs *(e.g.,* fever, anorexia, bleeding). The onset varies from acute (trauma, infection) to progressive (hip dysplasia-related osteoarthritis) or intermittent (patella luxation).

The expression of clinical signs differs depending on the species, with cats showing fewer signs than dogs.

The diagnosis requires careful history taking including: breed (size, predispositions), age (growth stage in relation with size of the adult dog), sexual status (neutering prior to cessation of bone growth can impact on bone elongation and joint formation), weight, nutritional regime, and breeding management (line selection, early detection, and assessment schemes, *e.g.,* hip dysplasia).

As overweight dogs are more likely to develop degenerative joint disease, weight gain should be prevented from an early age.

A thorough general clinical examination is also mandatory and often, diagnostic imaging is needed to precisely assess the lesions, and their extent and development. If an infectious agent is suspected *(e.g.,* bite wounds, calicivirus arthritis in cats), sampling of the lesion or synoviocentesis and joint fluid analysis may be indicated for bacterial culture and sensitivity, along with cytologic examination and a mucin clot test.

Dysplastic joints grow abnormally and predispose dogs to developing arthritis at a young age. Hip and elbow dysplasia are commonly seen in large breed puppies and can cause early onset arthritis and pain if not treated.

Congenital osteoarticular disorders

These can be hereditary (genetic) or non-hereditary and several orthopedic conditions are breed or size-related:

Legg-Calvé-Perthes disease

Avascular or aseptic necrosis of the femoral head. The exact cause remains unknown although a genetic etiology is suspected. It is most commonly seen in small dog breeds, under 10 kg/22 lb (mainly Terriers and Toy breeds). The treatment depends on the severity of the signs but surgery may be required (femoral head and neck osteotomy) or total hip replacement.

Shoulder/elbow dysplasia

The main developmental abnormalities leading to malformation and degeneration of the shoulder and elbow joint are **(Figure 1):**

- Osteochondritis dissecans (OCD) of the shoulder
- Ununited anconeal process (UAP)
- Fragmented Coronoid Process (FCP)
- Humeral condylar osteochondrosis
- Radius curvus: asynchronous growth between the radius and ulna due to premature closure of the ulnar physis

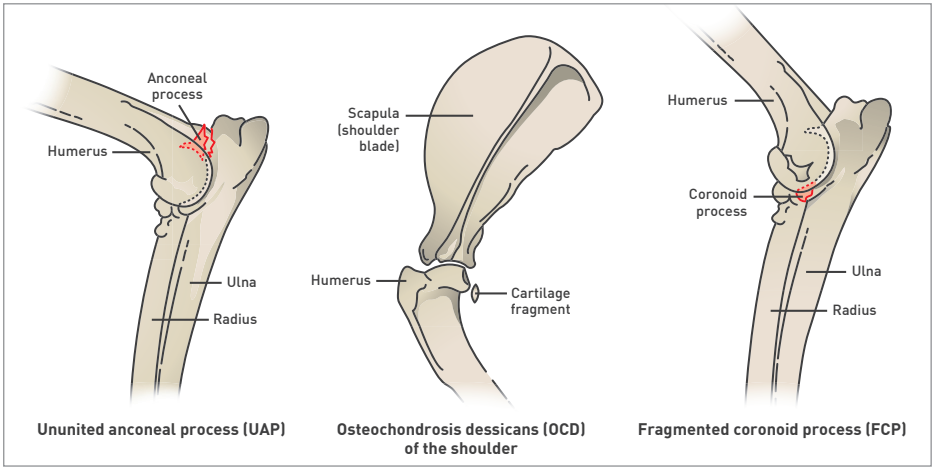


Figure 1. Schematic representation of the main developmental abnormalities of the shoulder and elbow joints.

Hip dysplasia

This developmental syndrome results in osteoarthritis of the coxofemoral joint. It is a genetic disease that is affected by factors such as diet, environment, exercise, growth rate, muscle mass, and hormones.

Hip dysplasia is far more common in dogs than in cats. Because of the hereditary component, some dog breeds are predisposed such as the German Shepherd or Labrador Retriever, leading many national kennel clubs to implement screening schemes. The hereditary disease is rare among crossbreed cats and more commonly occurs in large purebreds like the Maine Coon and Himalayan. However, it may be more common than usually thought because cats master the ability to mask their symptoms.

Patellar luxation

Many toy or small breed dogs have a genetic predisposition for (usually medial) patellar luxation **(Figure 2).** Cats may be affected too, and there may be a genetic predisposition to this problem in Devon Rex and Abyssinian cats.

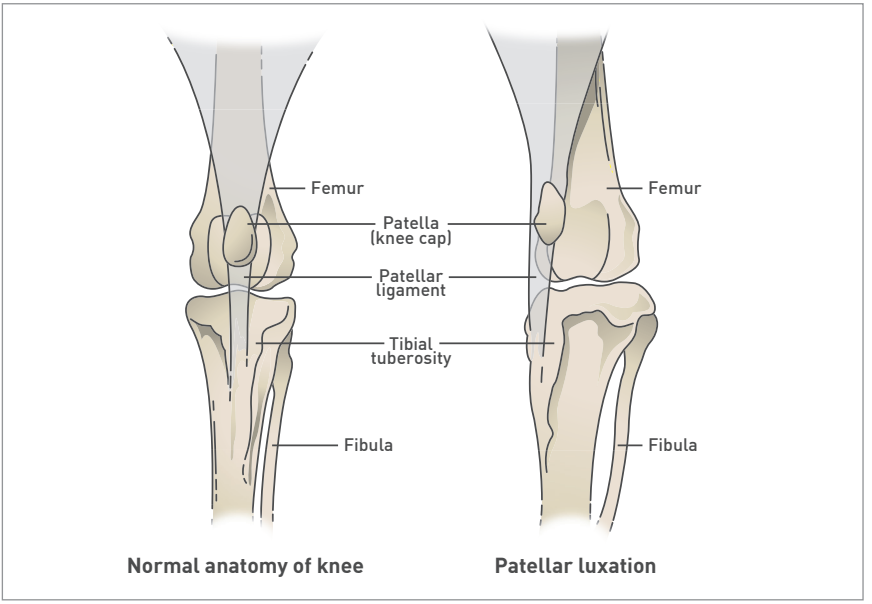


Figure 2. Schematic representation of the knee joint in normal and patellar luxation situations.

Acquired osteoarticular disorders

Traumatic causes

These are very frequent in young dogs and cats and can be due to falls, traction, traffic accidents, bites, and so on **(Table 2).**

Special attention is recommended in case of trauma to puppies and kittens, especially if repeated or accompanied by doubtful history such as "the puppy fell off the sofa" in the presence of lesions that do not match the story. Veterinarians are the best-trained individuals to recognize and address improper animal welfare. Studies have shown a link between domestic violence and pet abuse.

Fractures may occur and ongoing growth warrants a careful and specific therapeutic approach. Salter-Harris fractures **(Figure 3)** are specifically seen in young growing animals and involve the growth plate, the weakest part of the bone. If fractured, surgery needs to be performed as soon as possible. Because the bones are still growing, an adapted fixation method is required that does not compromise the growth and remodelling process.

Table 2. Differential diagnosis of lameness in skeletally immature cats.

Diagnosis	Relative frequency of occurrence in cats < 2 years
Cat bites	++
Fractures	++ (often physeal)
Traumatic luxations	+
Avulsion injury (tibial tuberosity, etc.)	++
Septic arthritis	++
Periosteal proliferative polyarthritis	++
Calicivirus arthritis	++
Other immune mediated polyarthritis	+
Osteoarthritis	–
Hip dysplasia	++ (predisposed breeds)
Patellar luxation	++ (predisposed breeds)
Cranial cruciate ligament rupture	–

From Scott HW and McLaughlin R. Feline Orthopedics. *Manson Publishing* 2007.

After surgery, the importance of restricting activity of the puppies/kittens to avoid any delay in the healing process should be emphasized. Advising pet owners to train their puppies and kittens to walk on the leash or stay in a crate may turn out to be useful in these situations.

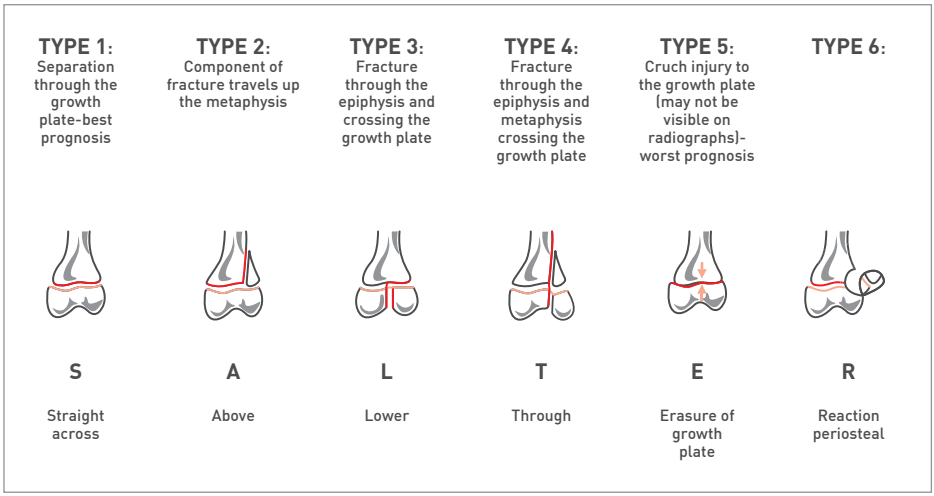


Figure 3. Salter-Harris Classification Mnemonic.

Infectious causes

These include septic lesions (bites, trauma) and Lyme borreliosis.

Toxic causes

Fluoroquinolones (enrofloxacin) can cause arthropathy in young dogs.

Metabolic and nutritional causes

An unbalanced diet can lead to osteoarticular disorders:

- An all-meat diet can lead to generalized osteopenia and pathologic fractures.
- Calcium and phosphorus imbalance can lead to disorders such as nutritional osteodystrophy or secondary/nutritional hyperparathyroidism (chronic elevation of circulating parathyroid hormone resulting from low serum ionized calcium concentration). Although the health consequences of calcium/phosphorus imbalance in puppy diets are well documented, calcium supplementation is still often advised for large dogs but should be avoided.
- Vitamin D deficiency will result in bone change and rickets.

Treatment involves adapting the diet (though changes may not be reversible) and potentially surgery if the skeletal disorders are affecting animal welfare.

Immune mediated osteoarticular causes

Though the phenomenon tends to occur in older animals, some disorders can appear toward the end of growth. Inflammatory polyarthritis secondary to the deposition of immune complexes can produce erosive (destruction of articular cartilage and subchondral bone) or non-erosive (periarticular inflammation) joint disease such as rheumatoid arthritis, Greyhound polyarthritis, feline progressive polyarthritis (males mainly), and systemic lupus erythematosus.

Treatment involves anti-inflammatory medications *(e.g.,* corticosteroids) and chemotherapeutic agents *(e.g.,* cyclophosphamide, azathioprine, or methotrexate). Prognosis is guarded because of relapses and the inability to determine the inciting cause of the autoimmune reactions.

Idiopathic osteoarticular disorders

- **Panosteitis:** a spontaneous, self-limiting, painful condition of the diaphyseal and metaphyseal portions of long bones, common in young (5 months to 1 year) medium, large, and giant breed dogs. The clinical signs include acute lameness of variable severity affecting a single bone or limb or "shifting leg" lameness, and last 1-3 weeks, waxing and waning in severity. Systemic signs can be present such as fever, anorexia, or lethargy. The etiology is unknown and there is no specific therapy beside analgesia.

- **Hypertrophic osteodystrophy** (HOD) is caused by an inflammation in the growth plates of the long bones. The condition affects rapidly growing giant and large breed puppies. It usually causes swelling and pain in the joints, which may cause fever and loss of appetite but is self-limiting in most dogs. However, some dogs may suffer permanent damage to the growth plates, resulting in deformed limbs. Treatment aims to relieve the pain and suppress the inflammation and can include non-steroidal anti-inflammatories (NSAIDs) or corticosteroids (prednisone).

- **Specific breed diseases:** Akita Inu arthritis.

GENITAL DISORDERS IN PUPPIES AND KITTENS

Genetic, developmental, traumatic, and infectious conditions can lead to genital disorders in puppies and kittens. A surgical procedure is often part of the treatment.

Most frequent genital disorders

Clitoral hypertrophy

This is most commonly associated with a mismatch between phenotypic sex and gonadal or chromosomal sex. In rare cases, clitoral enlargement **(Figure 1)** may also be secondary to anabolic drugs administered during pregnancy or severe prepubertal vaginitis. Genotypic sexual differentiation disorder may be related to androgen receptor defect, Müllerian duct persistence syndrome, or XX sex reversion syndrome.

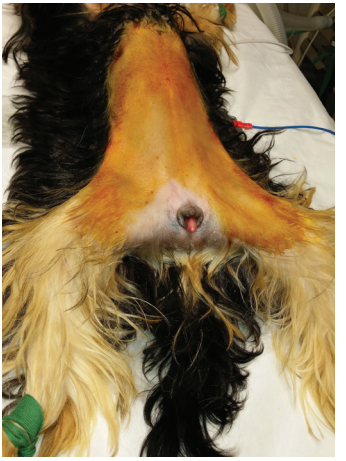


Figure 1. Clitoral hypertrophy in female Yorkshire Terrier.

Depending on the degree of involvement, affected animals have testes, or both male and female gonadal tissues. In the case of genotypic defects, an abnormally elongated, trough-shaped vulva is observed from the first few weeks, leading to vulvitis (or even vaginitis). The clitoris is rarely enlarged before puberty. A cartilage (more or less prominent) is sometimes palpable within it.

An autosomal recessive condition has been described in many breeds, including in the English and American Cocker Spaniel (very common), Beagle, Pug, Kerry Blue Terrier, Weimaraner, Doberman, Pointer, Basset Hound, Vizsla,

Pomeranian, Pinscher, American Staffordshire Terrier, Border Collie, and Afghan Greyhound.

Diagnosis is based on clinical examination, karyotype, genital ultrasound, and histology of the sexual gonad.

Treatment consists of the amputation of the penile clitoris in cases of repeated mutilation (licking, rubbing, etc.).

Prepubertal vaginitis

Prepubertal vaginitis **(Figure 2)** is caused by vulvar entropion, a burying of the vulva in the perineum. Most of the time the disorder is idiopathic, with some breed predisposition, including the Golden Retriever and the Saint Bernard.

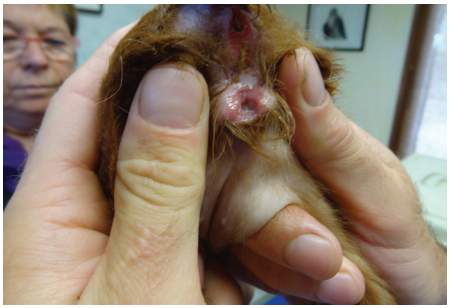


Figure 2. Prepubertal vaginitis in a female Cavalier King Charles.

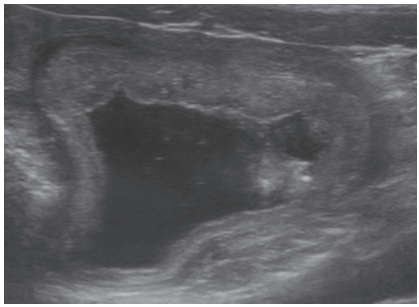


Figure 3. Recurrent cystitis related to chronical prepubertal vaginitis.

It is rarely seen before 8 weeks of age. Clinical signs include mucoid to purulent vulvar discharge, with often frenzied licking of the vulvar region, peri-vulvar dermatitis, and recurrent cystitis **(Figure 3).**

In most cases, the vaginitis resolves spontaneously after the first two heats. Treatment consists of topical anti-inflammatories and antibiotics. Local antiseptics should be avoided as these can promote the growth of certain pathogens with repeated treatment. Systemic antibiotic therapy is often disappointing. In case of persistent vaginitis, the animal should not be neutered early.

Testicular ectopia (cryptorchidism)

This is a defect in the descent of one or both testes into the scrotal pouch. The main cause is genetic (autosomal recessive genes with incomplete penetrance).

Small dog breeds and Persian cats are over-represented. Affected animals should be removed from any breeding program.

The condition may be unilateral (80% of cases, most often on the right) or bilateral. At birth, the testicles are located near the inguinal ring and at 5 weeks they are normally already in the scrotum. An absence of testes at 8 weeks is considered abnormal, but it will take six months before a definite diagnosis of an ectopic testis can be made.

In cats, the condition remains rare, but descent can occur later (6-8 months). Localization is always possible by ultrasound and helps to define the incision site for surgery **(Figure 4).**

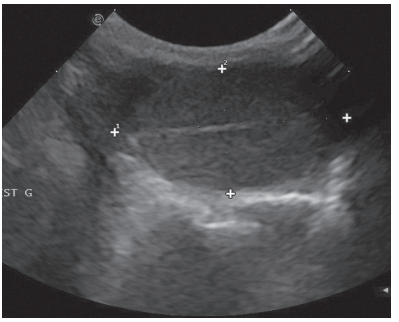


Figure 4. Case of cryptorchidism observed by ultrasound.

No medical treatment has been proven to be effective when compared to a placebo, but the following empirical treatments can be tried:

- Allopathy: human chorionic gonadotropin (five injections of 50 IU/kg q48h. Repeat after an interval of 10 days).
- Homeopathy: Pulsatilla 5 CH and Testosterone 5 CH, five granules of each q12h until positive results are obtained.
- Osteopathy.
- Acupuncture.

Castration is recommended (via laparotomy or laparoscopy) if the testicle is not in place by adulthood.

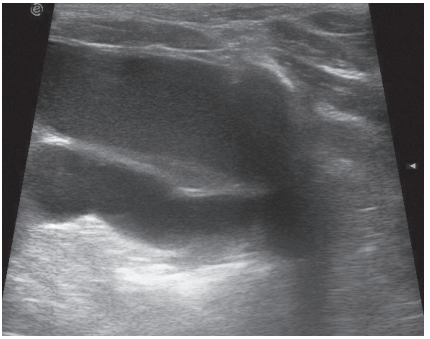


Figure 5. Ectopic ureter by ultrasound in a 5-week-old puppy.

Figure 6. Phymosis in a male German Shepherd puppy with dysuria.

Orchidopexy is possible with bilateral vasectomy. Orchidopexy does not seem to increase the risk of tumor formation if performed well before puberty and provided that the surgery is atraumatic for the gonad. See **Table 1** below for less common genital disorders.

Table 1. Other less common genital disorders.

Congenital disease	Breed predisposition	Etiology	Clinical manifestations/Diagnosis	Treatment
Ectopic ureter **(Figure 5)**	Labrador, Golden Retriever, Husky, Newfoundland, Bulldog, West Highland White Terrier, Fox Terrier	Results from an anomaly during embryogenesis	Young animals (< 6 months), 90% females. Often diagnosed during house-training age (2-4 months). Permanent or intermittent urinary incontinence, drop by drop, since birth or weaning Urinary soiling of the coat in the perivulvar or preputial region. Chronic recurrent cystitis, ascending pyelonephritis (rare). Diagnosis: Radiography Intravenous urography (efficacy 70-90%) or retrograde vaginourography (sensitivity 80%). Ultrasound (sensitivity 90%): difficult in practice. Urinary tract CT (sensitivity > 90%). Vagino-uretro-cystoscopy (sensitivity > 90%).	Surgery (remove from breeding program)
Paraphimosis (or preputial hypoplasia)	None	Consequence of hypoplasia of the prepuce (often preputial agenesis). The anomaly may be associated with hypospadias.	Permanently dry penis (glans), marked balanoposthitis, cystitis	Surgical treatment: pedicle flap (severe cases) or phallopexy in the sheath (limited paraphimosis)
Phimosis (or preputial stenosis) **(Figure 6)**	German Shepherd, Bouvier des Flandres, Labrador Retriever, and Golden Retriever	Narrow preputial orifice	Inability to externalize the penis. Localized sheath edema, erythema, and pain. Occasionally preputial discharge (balanoposthitis). Lameness and acute post-renal failure if urethral obstruction.	Surgery

ENDOCRINE DISORDERS IN PUPPIES AND KITTENS

Endocrine diseases affect the hormone-producing glands. While most tend to affect adult dogs and cats, puppies and kittens can occasionally be affected. They can lead to clinical signs (polyuria, polydypsia), but can also impact growth (stunted or abnormal growth pattern).

Thyroid problems

The main function of the thyroid gland is to produce triiodothyronine and thyroxine, which have various effects in the body including controlling metabolism. In dogs, most cases of hypothyroidism develop in middle-aged dogs, although a small number of cases (3.6%) occur in dogs under a year of age (congenital hypothyroidism). These most commonly arise from aplasia or hypoplasia of the thyroid gland. Rarely, there may be other causes such as iodine deficiency (unbalanced diet) or auto-immune destruction. Occasional cases of congenital hypothyroidism have also been reported in kittens.

Thyroid hormones play an important role in the development of the skeleton during growth. As a result, puppies and kittens with congenital hypothyroidism are stunted (dwarfism); unlike the stunting seen with growth hormone deficiency, this dwarfism is disproportionate, and the limbs are disproportionately short. Thyroid hormones are also important for the development of the nervous system, and puppies and kittens with congenital hypothyroidism have many neurological problems. These include poor coordination, vocal impediments, problems with visual awareness, and mental retardation. While mental retardation probably also occurs in puppies and kittens with congenital hypothyroidism, this is difficult to quantify because there are no objective tests for the purpose. Another neurological issue that can occur are problems with gait because of abnormal development of the cerebellum. Other signs that can be observed include lethargy, reduced appetite, macroglossia, skin and haircoat problems (including retention of the puppy haircoat and thinning), distended abdomen, delayed eruption of the teeth, constipation, and hypothermia.

Diagnosis of congenital hypothyroidism is based on clinical signs, supporting clinical pathology, and thyroid function testing; a serum thyroxine concentration below the levels normally expected in an animal of the same age will confirm the diagnosis. Other findings in blood tests would include very high cholesterol concentrations.

The treatment of congenital hypothyroidism involves replacing the missing thyroid hormone. If cases can be identified and treated quickly enough, the physique of the puppy or kitten could return to normal. Lifelong therapy is usually required, with the exact amount being adjusted based on regular blood tests to check thyroid hormone levels.

Pituitary gland problems

The pituitary gland is critical for many functions in the body, including growth, blood pressure, aspects of metabolism, temperature regulation, pain relief (endorphins), control of water, and electrolyte balance. Its functions result either from producing key hormones of its own (including growth hormone and vasopressin) or releasing hormones that control other glands including the adrenal glands, thyroid glands, and the sex organs. The function of the pituitary gland itself is controlled by the hypothalamus, which sends signals to the pituitary in response to the levels of the various hormones in the body. In young animals, there can be problems with the development or function of different parts of the pituitary gland, resulting in conditions such as pituitary dwarfism and diabetes insipidus.

Pituitary dwarfism

Pituitary dwarfism, much more commonly seen in dogs than cats, occurs if the anterior pituitary gland does not develop properly. It is common in German Shepherd dogs aged 2-6 months, where a genetic anomaly has been identified. Other breeds can also be affected including the Weimaraner, Spitz, and Toy Pinscher. The condition results from a decrease in the production of various hormones including growth hormone, thyroid-stimulating hormone (TSH), adrenocorticotropic hormone (ACTH), and also the luteinizing hormone (LSH) and follicle-stimulating hormone (FSH).

Puppies with pituitary dwarfism are usually first identified when not growing normally at about 2-3 months of age **(Figure 1).** Unlike dogs with congenital hypothyroidism, the dwarfism is proportionate: they

Figure 1. German shepherd dog puppy with dwarfism (right), alongside one of its littermates (left) who was unaffected.

simply resemble a smaller version of a dog of the same breed. There may also be problems with house training, thought to be the result of mental retardation.

Other signs include skin and haircoat changes *(e.g.*, retained puppy haircoat, thin skin, local alopecia, and hyperpigmentation), dental disorders (unerupted teeth), and genital hypoplasia.

Diagnosis is based on a blood test to confirm very low concentrations of insulin-like growth factor 1 (IGF-1). Other tests include the ACTH stimulation test and the TSH stimulation test.

Treatment of pituitary dwarfism is somewhat challenging because canine growth hormone therapy is not available. The use of human growth hormone has been trialed, but success has been limited, not least because the dog produces antibodies against it. More recently, progestins such as proligestone injected every 3 weeks can induce the production of growth hormone in the mammary glands. Potential side effects include acromegaly and uterine disorders. In some cases, thyroid supplementation can also help, in particular if thyroid function is decreased. Overall, the prognosis for puppies with pituitary dwarfism is fair, with treatment not only improving quality of life but also improving overall lifespan.

Central diabetes insipidus

Diabetes insipidus is a condition where the control of water and electrolyte balance in the body is severely disturbed; it can be central or nephrogenic. The central form occurs in male and female puppies of any breed, with signs typically developing by six months of age. The condition is the result of a failure to produce vasopressin (anti-diuretic hormone); this deficiency means the kidneys are no longer able to retain water and salts, leading to the constant production of very dilute urine. This leads to excessive urination, incontinence, nocturia, and polydypsia (often more than 100 mL per kg/day).

A diagnosis of dehydration involves first ruling out other possible causes of excessive urination and thirst, usually by performing blood and urine tests. Next, a water deprivation test is performed. Dogs with diabetes insipidus cannot concentrate their urine even to the point of becoming slightly dehydrated (~5%). To differentiate central diabetes from the nephrogenic form, synthetic vasopressin is injected, which should result in good concentration of the urine in case of the central form.

Treatment of diabetes insipidus involves a synthetic analogue called desmopressin, either in the form of tablets or as drops into the eye (using a human intranasal solution). The amount and frequency of administration needs to be adjusted to the response of each patient, and blood tests are often required to make sure that they remain healthy. However, once stable, most cases go on to do very well, living a more or less normal life.

Pancreas problems

In the exocrine part of the pancreas many digestive enzymes are produced for release into the small intestine. Within this tissue, the islets of Langerhans produce a number of hormones, the most important of which is insulin.

Diabetes mellitus (sugar diabetes) is a very common endocrine disease in adult dogs, but can also very occasionally develop in puppies and kittens. Cases of juvenile diabetes mellitus typically manifest between 3-6 months of age and result from the failure of insulin production by the pancreas. Although the cause is unknown, many cases might result from a viral infection. A genetic link has also been reported in dogs, with various at-risk breeds reported including Beagles, Dachshunds, Cairn Terriers, the Keeshond, Miniature Pinschers, Miniature Schnauzers, and Standard Poodles. Some dogs with juvenile diabetes mellitus also have a more generalized exocrine pancreatic insufficiency and a reduced production of digestive enzymes.

The signs of juvenile diabetes mellitus include stunting or weight loss (usually resulting from energy deprivation), loss of muscle mass, as well as polydipsia and polyuria. Puppies can also suddenly develop blindness (diabetic cataracts). If left untreated, puppies might become dehydrated and a ketoacidotic crisis might develop, requiring emergency veterinary attention.

The diagnosis of juvenile diabetes mellitus is based on compatible clinical signs (polyphagia, polydypsia) combined with increased blood and urine glucose concentrations.

Treatment of juvenile cases of diabetes mellitus is similar to the treatment for adults, most notably insulin therapy. This is typically given by subcutaneous injections twice a day, with the exact amount adjusted to the individual case. Food is often given 3-4 times per day, most often using a diet formulated for growth. Treatment can be more challenging than in adults because puppies and kittens are growing rapidly at the time, and this can often change the insulin requirement.

- Endocrine disorders are much less common in puppies and kittens than it adult animals.
- The thyroid gland, pituitary gland, and “endocrine” (hormone-producing) portion of the pancreas can be affected, usually as a result of the tissue not developing properly before birth.
- Treatment usually involves giving synthetic versions of the hormones that the glands are not producing themselves.

OPHTHALMIC CONDITIONS IN PUPPIES AND KITTENS

Kittens and puppies are frequently presented at the clinic with "eye problem," the origin mainly being congenital, traumatic, or infectious. Early diagnosis and treatment can reduce the likelihood of disability and lifelong side effects.

General considerations

Kittens and puppies are born blind. Their eyelids open at 10-14 days of age. The cornea initially appears cloudy, probably due to the high-water content, but this will clear within 24 hours. The thickness of the cornea decreases until 6 weeks of age. At 3 months of age, the intra-ocular pressure reaches its adult value.

Canine neonates produce tears by the fourth week of life, which can be successfully measured with the modified Schirmer tear test, but total (reflex + basal) tear secretion is less than adults.

The pediatric ophthalmic examination must take into account the age of the puppy/kitten. For example, the menace reflex is poor initially and will gradually improve until 6-8 weeks of age, as the retina continues to differentiate.

Events happening during pregnancy can impact the sight of kittens and puppies. Heredity as well as *in utero* infections *(e.g.*, distemper) or toxins may induce multiple abnormalities. Teratogenic factors during early gestation will have the greatest impact on ocular development, as the eye develops in early embryonic stages. For example, the administration of griseofulvin to a pregnant cat can cause microphthalmia in her offspring. Taking a careful history of the mother is therefore paramount in pediatric ophthalmology.

In practice, for breeds with a known risk of specific eye condition(s), it is recommended to perform genetic tests if available*. Although some diseases may not be clinically obvious at the first consultation, they will gradually become symptomatic. For diseases progressing during the first years of life and leading to blindness, the owner must be aware of the likely outcomes since it may impact the future of the pet/owner relationship or the use of the dog *(i.e.,* working dogs).

*https://www.vet.upenn.edu/research/academic-departments/clinical-sciences-advanced-medicine/research-labs-centers/penngen/penngen-tests/genetic-tests

Congenital eye diseases

These conditions may be genetic or related to an event during pregnancy.

Globe and orbit

- Anophthalmos: complete absence of the globe (rare).
- Microphthalmia: small globe. It is often associated with a correspondingly small palpebral fissure. Vision may be normal, impaired, or absent. It can be unilateral or bilateral. Enucleation may be necessary in case of discomfort or secondary disease of the cornea.
- Cataract: partial or total opacity of the lens. May be primary (hereditary) or secondary to congenital abnormality.
- Congenital alacrima (congenital keratoconjunctivitis sicca): dry eye.
- Corneal dystrophy: can affect different layers of the cornea (epithelial, endothelial, stromal).
- Iris hypoplasia: atypical eye position (lateral deviation in brachycephalic dog breeds, strabismus in Siamese and Himalayan cats) or eye motion (wandering movement of the eyes in puppies and kittens is associated with congenital blindness). Nystagmus is commonly observed in Siamese kittens, and it is thought to be linked to strabismus but the vision is functionally normal.

Eyelids

- Premature or delayed opening: eyelid separation is induced by a gradual increase in tear production and happens at 1-14 days of age.
- Other conditions include entropion, ectropion, distichiasis, trichiasis and ectopic cilia, eyelid agenesis.

Conjunctiva

- Dermoid: congenital ectopic mass of tissue containing skin, hair follicles, and sebaceous gland **(Figure 1).**
- Medial canthal trichiasis: hair arising from the medial canthal caruncle which can damage the cornea and misdirect tears.

These conditions usually require corrective surgery since they cause discomfort and will induce conjunctivitis and possibly corneal lesions.

Lacrimal system

- Lacrimal puncta atresia: rather common in breeds such as the American Cocker Spaniel, Golden Retriever, Poodle, and Samoyed. The imperforate lumen can be seen as a cream-colored fluid beneath a thin layer of conjunctiva. It can be surgically opened to restore the normal tear flow.

Third eyelid (nictitating membrane)

- Cartilage eversion ("cherry eye") appears as an outward curling of the nictitating membrane. This causes secondary irritation and requires surgical replacement. Often seen in the Great Dane, Saint Bernard, Weimaraner, German Shorthaired Pointer, and Irish Setter but also in Burmese cats.

Cornea

- Corneal opacity: a healthy cornea achieves and maintains transparency due to the organization of constituent cells and collagen fibers, as well as its relatively hydrated state. Anything that alters this organization or deturgescence leads to corneal opacity *(e.g.,* oedema, lipid/mineral deposition, vascularization).
- The clinical signs associated with a dermoid can include epiphora, blepharospasm, conjunctivitis, and blepharitis due to irritation of the associated ocular structures in contact with the hairs. Surgical treatment is required to remove a corneal dermoid using a superficial keratectomy procedure to excise the abnormal tissue from normal underlying tissue. The prognosis following surgery is good provided all abnormal tissue is removed.

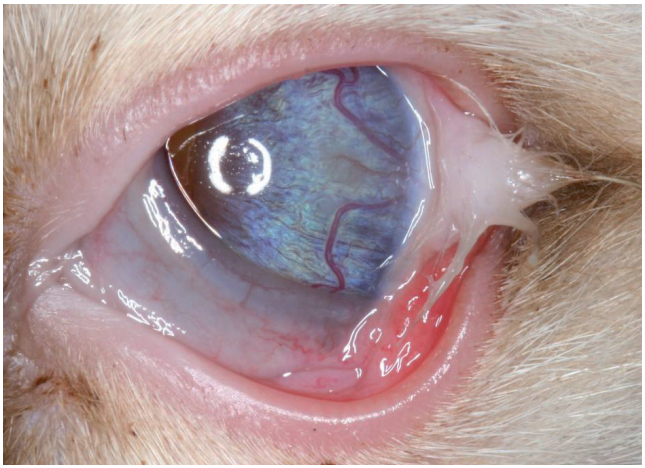


Figure 1. Conjunctival dermoid with a protruding tuft of hair causing conjunctivitis in a 3-month-old Birman.

- Symblepharon: this condition is uncommon in dogs. In cats, adhesion of the conjunctiva to the adjacent conjunctiva or cornea are common sequelae of infection (FHV-1) occurring before eyelid separation. The extent of the lesions is variable, ranging from a thin vascular membrane to severe obstruction and impaired vision.

Anterior uvea

- Anterior uveal cysts. Congenital defect due to the embryological failure of adhesions between the layers of the optic cup that can be found in one or both eyes. Treatment recommended only in case of secondary issues related to a large size of the cysts.
- Heterochromia (zones of different color in a single iris or the color of one iris differing from the other). No clinical significance on vision but association between heterochromia and congenital deafness has been described in blue-eyed, white cats and several canine breeds (Australian Cattle Dog, Australian Shepherd, Boston Terrier, Dalmatian, English Bulldog, English Setter, and Old English Sheepdog). The hearing of any puppy/kitten with heterochromia should be checked.
- Pupillary abnormalities and persistent pupillary membrane (PPM) **(Figure 2)** may accompany other functional anomalies since they result from embryonic abnormalities. PPM can occur unilaterally or bilaterally and appear as fine, filamentous, and pigmented attachments originating from the iris collarette (the mid region of the iris) and can attach to other ocular structures such as corneal endothelium, lens, iris, or float free in the anterior chamber.

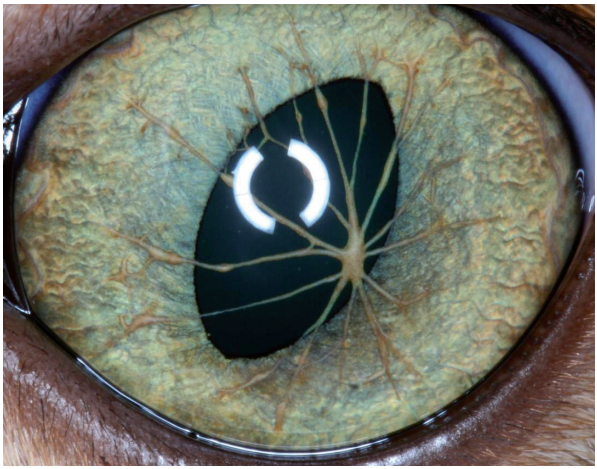


Figure 2. Persistent pupillary membrane remnants meeting centrally in the anterior chamber.

Diagnosis of a PPM is based on physical examination and must be differentiated from post inflammatory adhesions. Treatment is not usually necessary, but the treatment options, if required, include topical mydriatics and surgical transection.

Glaucoma

Glaucoma is defined as an optic neuropathy resulting in a loss of sight. Many breeds are affected by primary glaucoma or primary lens luxation. This is a painful blinding disease without a cure. Normal intraocular pressure (IOP) ranges from 8 to 18 mm Hg. The primary complaint is rapid and dramatic globe enlargement. The goal of therapy is to return and prolong vision through the control of IOP. Early referral to a veterinary ophthalmologist is recommended.

Lens

With the exception of cataracts, congenital anomalies of the lens are rare. Congenital cataracts may be inherited (numerous breeds listed) or secondary to *in utero* influences.

Retina and optic nerve

Ophthalmoscopic examination of puppies or kittens is rather challenging and can only be performed on animals over eight weeks of age. There are several congenital abnormalities:

- Collie eye anomaly: choroidal hypoplasia is the fundamental defect. Coloboma of the optic disc is found in 35% of affected animals but overall vision remains functional. Extensive coloboma may predispose to retinal detachment.
- Microphthalmia with colobomas (autosomal recessive trait).
- Retinal folds, retinal dysplasia. Retinal detachment may occur secondary to concurrent vitreous abnormalities. Visual impairment is frequent.
- Congenital stationary night blindness (Briard).
- Tapetal Hypoplasia, optic nerve hypoplasia, optic nerve coloboma.

Progressive Retinal Atrophy (PRA)

This is an inherited progressive disease of the retinal photoreceptors that leads to blindness. It is rare in cats. Dogs with PRA start showing visual deficits in dim lighting. The pupils dilate as the disease progresses. Predisposed breeds include Poodles, Labrador and Golden Retrievers, English and American Cocker Spaniels, Australian Cattle Dogs, Tibetan Terriers and Spaniels, Cardigan Welsh Corgis, Irish Setters, Shetland Sheepdogs, and Spitz.

Acquired eye diseases

Their etiology may be broadly classified into three main groups: trauma, infectious, and others (ophthalmic expression of systemic diseases, allergic reactions, neoplasia, toxicosis).

The lesions may affect different parts of the eye or the surrounding structures and lead to impaired vision or blindness. The pain must never be overlooked. Early attention is mandatory to preserve vision as much as possible (*e.g.*, exophthalmos in brachycephalic breeds).

A penetrating injury from the oral cavity may induce an orbital abscess, so carefully check the mouth of all puppies and kittens.

Conjunctiva

Numerous factors can induce conjunctivitis in puppies and kittens. An etiological diagnosis should be determined to prescribe the best treatment and avoid long term sequelae.

Conjunctivitis can be bacterial *(Staphylococcus* and *Streptococcus* in puppies; *Staphylococcus*, *Streptococcus*, *Chlamydia* and *Mycoplasma* in kittens), viral (herpesvirus in kittens), fungal, parasitic, immune-mediated, toxic or chemical, desiccation-related (tear film abnormalities, lagophthalmos, ectropion), allergic, or frictional (distichiasis, entropion, trichiasis, foreign body, dust, or particulate-induced). The duration (acute, subacute, chronic, or recurrent) is also an important factor to take into account as well as the appearance *(i.e.*, mucoid, purulent, etc.). Broadly speaking, feline conjunctivitis is often infectious while canine conjunctivitis is usually non-infectious (except canine distemper when other clinical signs are present).

When the eyelids are still closed, clinical signs include:

- Eyelids that appear swollen or bulge outward.
- Mucus, pus, or clear fluid leaking from the eye corner.

Once the eyelids are open, eye infections are characterized by:

- Conjunctival redness or swelling.
- Abnormal eye discharge (mucus, pus, or clear fluid).
- Crusty eyelids or debris that sticks the eyelids together.
- Cloudy cornea (corneal scars or ulceration).
- An eyelid adhering to the eye surface.
- An eye that appears to have a “flat” surface.

In addition, there can be other non-specific signs such as sneezing, coughing, hyperthermia, or decreased appetite.

With neonatal ophthalmia the initial treatment is to fully open the eyelids and clean the discharge. Then, topical treatment (artificial tears, antibiotics, antiviral, etc.) may be applied according to the cause of the inflammation. No corticoids should be applied in case of infection. Early intervention should limit any long-term consequences.

Severe infections, or those left untreated, can lead to corneal scarring, symblepharon, keratoconjunctivitis sicca, or even blindness.

In cases of infectious disease, prevent cross-contamination of siblings by considering treating the entire litter. A clean maternal environment should help to prevent infections.

Cornea and sclera

Corneal ulceration is usually secondary to dry eye, foreign body, entropion with or without macroblepharon/ectropion, or distichiasis. Keratoconjunctivitis sicca (KCS, dry eye) is a common disease characterized by reduced aqueous tear production leading to drying and inflammation of the conjunctiva and cornea. It may be congenital but usually results from infection, drug, neurological, or immune-mediated causes. A genetic influence is suspected. Corneal lesions are frequent in cats (feline herpesvirus keratitis).

Lacrimal system

- Early diagnosis of any disturbance, abnormalities in the quantity or quality of the tear film can cause dehydration of the conjunctiva and corneal epithelium, hypoxia of the corneal epithelium, lack of lubrication, and subsequent frictional irritation, disturbance of the microbiome, secondary inflammation, corneal erosion, or ulcers.
- Chronic conjunctivitis and keratitis are often linked to a deficiency in one or more of the layers of the precorneal tear film.
- Epiphora: always check tear ducts.
- Cherry eye: the prolapsed gland of the third eyelid is best treated by replacement, not by excision. Indeed, excision may lead to secondary conjunctivitis and keratitis (including KCS).
- Useful and easy to implement diagnostic methods:
  - Schirmer tear test to assess quantitative abnormalities of tear production.
  - Fluorescein for corneal ulceration and tear duct permeability.

Uvea

Anterior uveitis must be distinguished from other conditions causing red eye (conjunctivitis, keratitis, glaucoma). Since the uvea is involved in many systemic disorders, the possible underlying cause must be identified. The following etiology should be considered: infectious (algal, bacterial, fungal, viral, protozoal, parasitic), immune-mediated, neoplastic or paraneoplastic (rare in puppies and kittens), metabolic, traumatic, toxic, and idiopathic.

When considering potential zoonotic diseases, a thorough differential diagnostic workup is important *(e.g.,* rabies virus).

Vogt-Koyanagi-Harada-like syndrome or uveodermatologic syndrome. This condition affects certain breeds more than others: Akita, Old English Sheep Dog, Golden Retriever, Siberian Husky, and Irish Setter. It is a spontaneous autoimmune disease directed against melanin.

Differential diagnoses of uveitis in cats:

- Exogenous: septic, trauma (blunt or perforating), ionizing radiation, chemical injuries.
- Endogenous: infectious (FIV, FeLV, FIP, toxoplasmosis, leishmaniasis, bartonellosis, cryptococcosis, histoplasmosis, coccidiomycosis, blastomycosis, candidiasis, septic, ophthalmomyiasis interna), immune-mediated, neoplastic, metabolic, lymphoplasmacytic, idiopathic.

Lens

The lens is an avascular structure. Its metabolic needs are met by the aqueous humor. Anterior uveitis may affect lens metabolism and transparency. A loss of transparency of the lens or its capsule is called cataracts. Cataracts may be classified according to their cause, the location of the opacity, or the stage of evolution.

Dogs with hereditary cataracts (HC) should not be bred from. Ongoing research is seeking to find the responsible gene and tests are now available. For example, mutations in one gene called HSF4 have been shown to cause HC in a number of different breeds (Australian Shepherd, Boston Terrier, French Bulldog, and Staffordshire Bull Terrier).

DENTAL AND MAXILLOFACIAL DISORDERS IN JUVENILE PATIENTS

Oral disorders in juvenile canine and feline patients include abnormalities in tooth number, eruption pattern, and crown morphology as well as congenital malocclusions and cleft palates. Depending on the diagnosis, the irregularity may be cosmetic or require advanced treatment, especially if not treated promptly. A thorough oral examination of the juvenile population allowing early and accurate diagnosis is therefore paramount.

How many teeth should be present?

Canine

- Deciduous dental formula: I3/3, C1/1, PM3/3, M0/0 = 28 (there are no deciduous first premolars and no deciduous molars).
- Permanent dental formula: I3/3, C1/1, PM4/4, M2/3 = 42 **(Figure 1).**

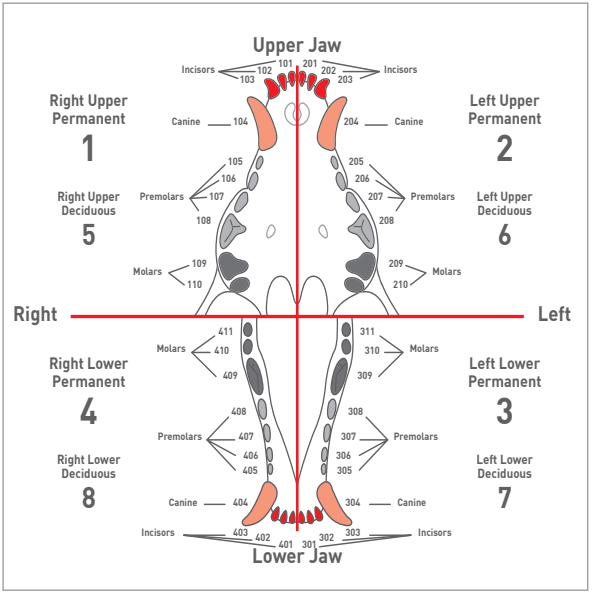


Figure 1. Canine jaw showing permanent dentition as well as the modified Triadan numbers used per quadrant to identify the teeth. When referring to deciduous teeth with this system 5-8 are used instead of 1-4 for each quadrant, respectively.

Feline

- Deciduous dental formula: I3/3, C1/1, PM3/2, M0/0 = 26 (there are no deciduous molars).
- Permanent dental formula: I3/3, C1/1, PM3/2, M1/1 = 30 **(Figure 2).**

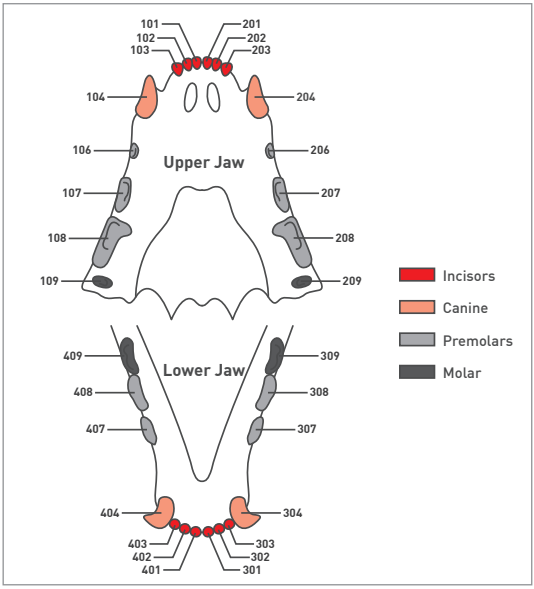


Figure 2. Feline permanent dentition. Note the teeth numbers using the modified Triadan system.

When should teeth erupt?

In general, deciduous teeth should be present by the time of the first round of vaccines and permanent teeth should be present at around 6 months of age. However, there is breed variation in eruption times, and these are not firm deadlines. Rather, concern should be raised if teeth have only erupted unilaterally.

	Canine deciduous	Canine permanent	Feline deciduous	Feline permanent
Incisors	3-4 weeks	3-5 months	2-3 weeks	3-4 months
Canine	3 weeks	4-6 months	3-4 weeks	4-5 months
Premolars	4-12 weeks	4-6 months	3-6 weeks	4-6 months
Molars	N/A	5-7 months	N/A	4-5 months

Too few teeth

Teeth may be absent due to delayed eruption, agenesis (tooth bud never formed), or impaction. Delays in eruption are most often bilaterally symmetrical. Dental radiographs are required to diagnose the reason for an absent tooth.

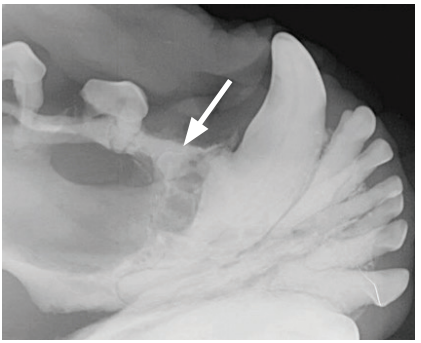


Figure 3. Large dentigerous cysts secondary to impacted first mandibular premolar (arrow).

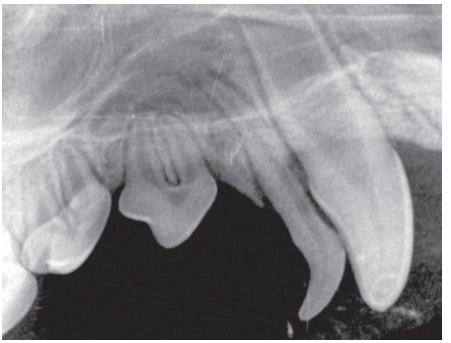


Figure 4. Radiograph of a persistent deciduous right maxillary canine. Note the permanent maxillary canine erupts mesial to the deciduous. All other permanent teeth erupt on the lingual aspect of the deciduous tooth. Extraction of the deciduous tooth is recommended as it is unlikely to exfoliate once the permanent has erupted and leads to crowding and secondary periodontal disease.

To the author's knowledge, impacted deciduous teeth have never been reported. Impacted permanent teeth are common in brachycephalic breeds, with the mandibular first premolar being the most commonly affected tooth. Approximately 30% of impacted teeth will develop dentigerous cysts, which have the potential to be highly destructive if left untreated **(Figure 3).** Thus, early extraction of impacted teeth is recommended.

Too many teeth

Too many teeth in the oral cavity may be due to persistent deciduous teeth or supernumerary teeth. Persistent deciduous teeth **(Figure 4)** require extraction as they may lead to malocclusion of the permanent tooth as well as crowding with subsequent periodontal disease. Supernumerary teeth, caused by an extra tooth bud, only require extraction if they are causing crowding and subsequent periodontal disease. Otherwise, no treatment is required.

Abnormal tooth crown morphology

Abnormal crown morphology may be developmental or due to trauma of the erupted tooth.

Developmental tooth disorders

Abnormal crown morphology may be hereditary or occur secondary to trauma/environmental changes that affect the developing permanent tooth bud in the first 8 weeks of life. Developmental abnormalities that do not require treatment include yellow discoloration of the teeth from tetracycline administered to the bitch while pregnant or within the first 8 weeks of life, enamel changes from fluorosis, geminated teeth, fused teeth, and concrescence **(Figure 5).**

Developmental abnormalities that require treatment include dens in dente, odontodyplasia, and enamel hypoplasia. Dens in dente, or "tooth within a tooth," occurs due to invagination of the tooth crown during odontogenesis. Pending the severity of tooth malformation, this abnormality puts the tooth at risk of pulp infection. Radiographic monitoring for evidence of non-vitality is strongly recommended. Treatment with root canal therapy or extraction is recommended if non-vitality is noted or for prophylactic purposes **(Figure 6).**

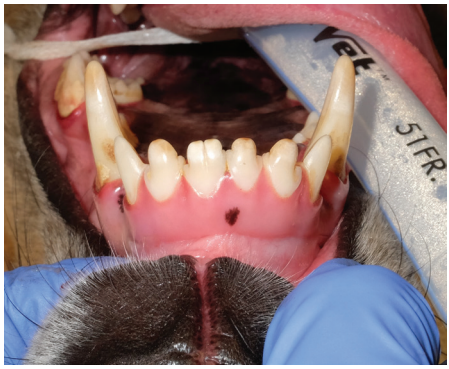


Figure 5. Example of a gemination tooth in a dog. This is a cosmetic anomaly.

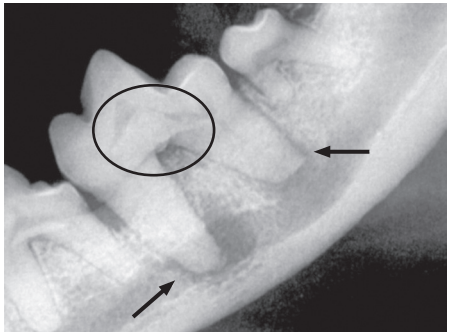


Figure 6. Mandibular first molar with dens in dente (circle pointing out tooth malformation). Note that the tooth developed a periapical lucency (arrows) that was observed with serial monitoring of the tooth, indicating tooth non-vitality.

Trauma to the developing tooth bud can result in odontodysplasia or enamel hypoplasia. Odontodysplastic teeth, defined as teeth that are completely malformed, are at risk of pulp infection and should be extracted. Teeth with enamel hypoplasia have areas of thin enamel that easily flakes off, exposing the sensitive dentine **(Figure 7).** Restorative treatment is indicated to protect these teeth. Pyrexia during tooth development may also result in enamel hypoplasia. However, in this case, all teeth in the oral cavity will be affected.

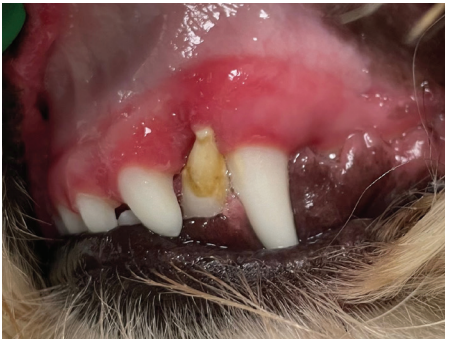


Figure 7. Enamel hypoplasia on the mandibular canine.

Trauma to an erupted tooth

Abnormal crown morphology may also be secondary to tooth fracture. Tooth fractures may be complicated or uncomplicated, depending on pulp exposure **(Figure 8).** Pulp exposure is painful and can lead to direct pulp infection and secondary apical periodontitis. Apical periodontitis is defined as bone loss around the apex secondary to abscess, cyst, or granuloma formation. Complicated fractures always require treatment. Treatment options include endodontic therapy to save the tooth (root canal therapy or vital pulp therapy) or surgical extraction.

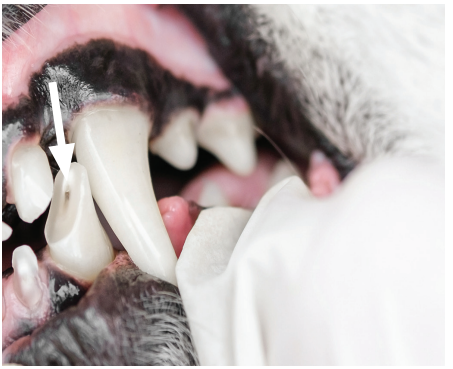


Figure 8. Complicated crown fracture of the left mandibular canine. Note the pulp exposure (arrow).

It is a common misconception that fractured deciduous teeth do not require treatment as they will exfoliate naturally. Fractured deciduous teeth are still at risk of developing apical periodontitis, which can affect the developing permanent tooth bud. Therefore, treatment with surgical extraction is indicated.

Malocclusions

Occlusion should be evaluated in all juvenile patients. Both deciduous and adult occlusion should be checked. Normal occlusion should meet the following criteria:

- Maxillary incisors are rostral to mandibular incisors. Mandibular incisors occlude with maxillary incisors at the cingulum.
- Mandibular canine sits in the diastema between the maxillary third incisor and maxillary canine.
- Premolar teeth interdigitate in a "pinking shear" fashion.
- Maxillary fourth premolar and molars sit on the buccal aspect of the mandibular molars.

Malocclusions are defined as class 1-4

- **Class 1 malocclusions:** normal skeletal relationship between the maxilla and mandible. Dental abnormality only. Common class 1 malocclusions include rostral crossbites, caudal crossbites, and base narrow canines.
- **Class 2 malocclusions:** the maxilla is longer than the mandible. With this malocclusion there is often trauma to the palate from the mandibular canines.
- **Class 3 malocclusions:** the mandible is longer than the maxilla. This is considered normal in brachycephalic breeds and is often asymptomatic.
- **Class 4 malocclusions:** one quadrant is longer than the others, leading to an abnormality in the horizontal plane.

For all malocclusions, a decision to treat is based on the presence of tooth on tooth contact and/or tooth on soft tissue contact. In these cases, treatment is required as all dogs and cats deserve a functional and comfortable bite. Cosmetic malocclusions are not treated.

When a malocclusion is noted in the deciduous dentition, selective extractions are recommended as early as possible. This removes pain and helps the permanent teeth to erupt in a normal position. In other words, the deciduous teeth will have less influence on the eruption pathway. Waiting for these teeth to exfoliate naturally is not recommended. For permanent teeth, treatment options include selective extractions, selective crown amputations with endodontic therapy, or orthodontic movement.

HELMINTH DISEASES IN PUPPIES AND KITTENS

During their first weeks of life, puppies and kittens may be at risk of being infected by worms (nematodes and cestodes), compromising their development and health. In addition to the preventive treatment of adults, even before mating, good environmental hygiene is mandatory to limit the spread of intermediate host and larvae.

Intestinal worms

Roundworms

Ascarids *(Toxocara* spp., *Toxascaris* spp.) are intestinal nematodes with a maximum length of about 10-15 cm in the adult forms **(Figure 1).** Puppies and kittens become infected through the ingestion of infective larval eggs from the environment or larvae carried by paratenic hosts, such as rodents. The transplacental passage of infectious larvae from the bitch to their fetuses is common during late pregnancy, while both puppies and kittens can also become infected by suckling milk from their mothers. After infection, roundworm larvae reach the small intestine after a complex migration involving a pulmonary

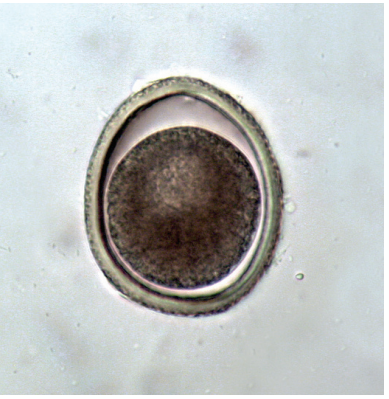


Figure 1. Egg of *Toxocara cati.*

phase. *Toxocara* spp. can cause serious disease in puppies and kittens; *Toxascaris* is generally less pathogenic. Clinical signs of ascarid infestation are generally mild, consisting of unthriftiness, potbelly, and occasional vomiting and diarrhea. In the case of massive transplacental infection, severe respiratory signs and even death can be observed in neonatal puppies due to pulmonary damage during larval migration, intestinal blockage, or intussusception. *Toxocara* spp. is zoonotic, with *Toxocara canis* causing visceral *larva migrans* in humans. Therapy is mainly based on the administration of anthelmintic medications, including macrocyclic lactones, pyrantel, piperazine, benzimidazoles and nitroscanate; all with a limited activity on larvae. For this reason, serial treatments are advised during the first months of life.

Hookworms

Hookworms (*Ancylostoma* spp., *Uncinaria* spp.) are small nematodes (1-2 cm in length) with sharp marginal teeth **(Figure 2).** The adult worms inhabit the small intestine. The infectious larvae are transmitted from dams to their offspring through lactation, but certain hookworm species can penetrate directly through the skin, giving rise to pulmonary migration before reaching the gut. The larvae can be also ingested from the environment. Clinical signs of hookworm infection are mucoid or bloody diarrhea,

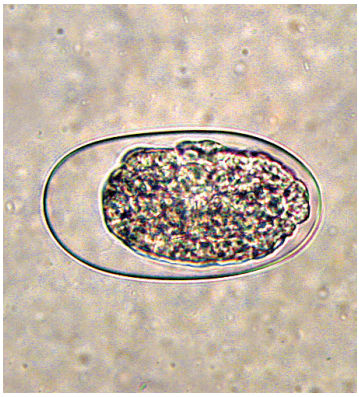


Figure 2. Egg of *Ancylostoma caninum*.

anemia, anorexia, lethargy, weight loss, and respiratory signs in the case of massive pulmonary migrations. Occasionally, skin lesions and lameness are observed. In humans, canine and feline hookworms are associated to cutaneous *larva migrans*. Apart from anthelmintic treatments with macrocyclic lactones, piperazine, benzimidazoles, or nitroscanate, young animals may require supportive therapy to restore their water-electrolyte balance.

Tapeworms

Tapeworm infections cause no or few clinical signs in carnivores (final hosts), while in the intermediate host they can be associated with different clinical forms and even death depending on the localization of the larval forms. These parasites include several cestodes, with adult forms having variable sizes (from 2 mm to 15 m): *Echinococcus* spp., *Taenia* spp. **(Figure 3),** *Spirometra* spp., *Dipylidium caninum*, *Mesocestoides lineatus*, *Diphyllobotrium latum*, etc. The adults usually inhabit the small intestine of dogs and sometimes cats, while the larval forms develop in different intermediate hosts, such as ruminants, horses, rodents, reptiles, amphibians, fishes, birds, fleas, lice, mites, crustacea, and copepods. Therefore, dogs and cats become infected mainly through the ingestion of uncooked meat containing the larval forms, which can be fed by humans or from prey animals.

Figure 3. Eggs of *Taenia* spp.

The clinical relevance for puppies and kittens is limited, but some of these cestodes *(Echinococcus granulosus*, *Echinococcus multilocularis*, *Diphyllobotrium latum)* are responsible for severe zoonoses. The treatment of choice for tapeworms is praziquantel, although other drugs may be effective against some cestodes, including dichlorophen, nitroscanate, niclosamide, epsiprantel, bunamidine, and benzimidazoles.

Worms of the circulatory and respiratory systems

Heartworms

Heartworms include two nematodes, *Angiostrongylus vasorum* (up to 2.5 cm in length) and *Dirofilaria immitis* (up to 30 cm in length) **(Figure 4),** whose adult forms reside in the pulmonary arteries of dogs and cats and in the pulmonary arteries and the right side of the heart of dogs and other canids, respectively. Cats are not infected by *A. vasorum* (also known as French heartworm) and have a limited role in *D. immitis* epidemiology. Intermediate hosts are terrestrial mollusks (snails and slugs) and mosquitos *(Aedes* spp., *Anopheles* spp., *Culex* spp.) for *A. vasorum* and *D. immitis*, respectively. Dogs become infected with *A. vasorum* through the ingestion of intermediate hosts containing the infective larvae, or frogs or even birds acting as paratenic hosts. Infection of dogs and cats with *D. immitis* occurs through the bites from mosquitoes that transmit the infective larvae.

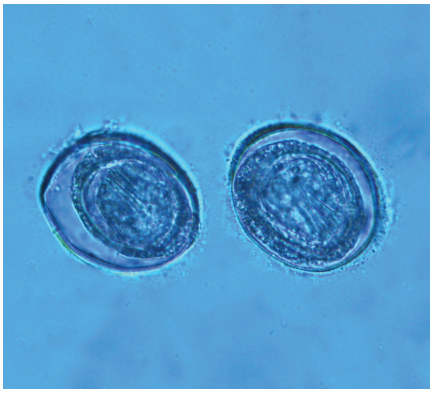


Figure 4. Adult nematodes of *Dirofilaria immitis.*

Clinical signs of heartworm infection can be severe depending on the worm burden. Young animals may develop fatal forms, with dyspnea, tachycardia, violent coughing, and bloody sputum or hemoptysis. In humans, *D. immitis* can cause aberrant infection with pulmonary involvement. The drugs of choice for French heartworm are mebendazole and fenbendazole, but levamisole and moxidectin have also proven to be effective. Drugs against *D. immitis* infections in dogs include melarsomine as adulticides and macrocyclic lactones as microfilaricides.

Table 1. Most common helminths of puppies and kittens.

Helminths		Definitive domestic carnivore host(s)
Roundworms	*Toxocara canis*	Dogs
	Toxocara mystax (cati)	Cats
	Toxocara malayensis	Cats
	Toxascaris leonina (limbata)	Dogs, cats
Hookworms	*Ancylostoma braziliense*	Dogs, cats
	Ancylostoma caninum	Dogs
	Ancylostoma ceylanicum	Dogs, cats
	Ancylostoma tubaeforme (Strongylus tubaeforme)	Cats
	Uncinaria spp.	Dogs, cats
Tapeworms	*Echinococcus granulosus*	Dogs
	Echinococcus equinus	Dogs
	Echinococcus orteleppi	Dogs
	Echinococcus multilocularis	Dogs, cats
	Echinococcus vogeli	Dogs
	Taenia pisiformis	Dogs
	Taenia hydatigena	Dogs
	Taenia (Multiceps) multiceps	Dogs
	Taenia (Multiceps) skrjabini	Dogs
	Taenia gaigeri	Dogs
	Taenia krabbei	Dogs
	Taenia ovis	Dogs
	Taenia crassiceps	Dogs
	Taenia (Hydatigera) taenieformis	Cats
	Taenia (Multiceps) serialis	Dogs
	Dipylidium caninum	Dogs, cats
	Mesocestoides lineatus	Dogs, cats
	Diphyllobotrium latum	Dogs, cats
	Spirometra mansoni	Dogs, cats
	Spirometra manonoides	Cats (dogs)
	Spirometra erinacei europae	Cats, dogs
Heartworms	*Angiostrongylus vasorum*	Dog
	Dirofilaria immitis	Dogs (cats)

Intermediate host(s)*	Localization of adults	Treatment
None	Small intestine	Pyrantel, piperazine, benzimidazoles, nitroscanate, avermectines, milbemycines
None	Small intestine	Piperazine, benzimidazoles, nitroscanate, avermectines, milbemycines
Ruminants, humans Horses Cattle Rodents, humans, (pigs, horses) Rodents Rabbits Ruminants Ruminants, humans Sheep Goats Reindeer Small ruminants Small rodents Small rodents Rabbits Rabbits 1. Oribatid mites; 2. Mammals, reptiles, frogs, birds* 1. Copepods; 2. Fishes 1. Copepods; 2. Amphibians, reptiles, birds 1. Crustacea; 2. Rats, snakes, mice 1. Crustacea; 2. Amphibians, reptiles	Small intestine	Praziquantel, dichlorophen, nitroscanate, niclosamide, epsiprantel, bunamidine, benzimidazoles, avermectines, milbemycines
Slugs, snails Mosquitoes *(Aedes* spp., *Anopheles* spp., *Culex* spp.)	Heart, pulmonary arteries	Mebendazole, fenbendazole, (levamisole, ivermectin) Melarsomine (adulticides); macrocyclic lactones (microfilaricides)

**Numbers refer to the order of mandatory intermediate hosts required in the reproductive cycle of the parasite.*

INFECTIOUS DISEASES IN PUPPIES AND KITTENS

Puppies and kittens are born with nearly no immunoglobulins. They get their first protection when ingesting colostrum. This "shield" won't last forever and they will soon face the immunity gap before vaccination is protective and after maternal antibodies decline. But even before this critical period they may suffer from infectious diseases. Many viruses and bacteria may cause clinical signs, most of the time non-specific, and can be fatal. Prophylaxis is key with a focus on vaccination and general environmental hygiene – starting long before parturition. Identification of the sick individual, isolation, and necropsy in the event of death are very important to adapt treatment and preventive care to protect the littermates.

Infectious diseases in puppies

Bacterial infections in neonatal puppies

Bacterial infections **(Table 1)** are a common cause of mortality in neonatal puppies. *Escherichia coli, Staphylococcus aureus, Streptococcus pseudointermedius, Pseudomonas aeruginosa,* and *Klebsiella* spp. are the bacteria most frequently associated with local (intestinal, cutaneous) or systemic disease (septicemia) in neonates. Bacteria can enter the bloodstream through the gastrointestinal tract (oral cavity), the peritoneal cavity via the umbilicus, the respiratory tract, skin and associated wounds, and the urinary tract. Most bacterial infections are transmitted vertically since *E. coli* and other enterobacteria may originate directly from the normal intestinal or vaginal flora of the bitch. The antibiotics that have been shown to be most effective against bacterial infections of neonates are amoxicillin/clavulanic acid and ampicillin. However, neonates present important differences with respect to adults, relating to the maturity of tissues and organs, which can reduce the absorption, tissue distribution, and availability of antibiotics at this age. Cephalosporins are also widely used, while gentamicin, chloramphenicol, sulphonamides, tetracyclines, and metronidazole should be avoided due to decreased renal excretion and/or reduced hepatic drug metabolism in neonates.

Table 1. **Infectious diseases in puppies.**

Etiology	Age	Clinical form(s)	Treatment	Outcome
Several bacterial species	< 3 weeks	Local infections, septicemia	Antibiotics (amoxicillin/clavulanic acid, ampicillin, etc.)	Septicemic forms frequently fatal
Canine herpes-virus-1, canine minute virus	< 3 weeks	Systemic neonatal disease	Supportive (fluid therapy, good nursing, antibiotics against secondary infections)	Mostly fatal
Canine parvovirus	More frequent in puppies < 6 months	Hemorrhagic gastroenteritis, leukopenia (lymphopenia)	Supportive (fluid therapy, antibiotics against secondary infections)	Often fatal
Canine coronavirus	More frequent in puppies < 6 months	Non-hemorrhagic gastroenteritis	Supportive (fluid therapy)	Rarely fatal
Canine adenovirus type 1	All ages (more severe clinical signs in puppies)	Systemic disease (gastroenteritis, respiratory signs, hemorrhages)	Supportive (fluid therapy, antibiotics against secondary infections, anticoagulants)	Often fatal
Canine distemper virus	All ages (more severe clinical signs in puppies)	Systemic disease (gastroenteritis, bronchopneumonia, pyoderma, hyperkeratosis of the foot pads, neurological signs)	Supportive (fluid therapy, antibiotics against secondary infections)	Often fatal
Respiratory viruses and bacteria	All ages (more severe clinical signs in puppies)	Canine infectious respiratory disease	Glucocorticoids, antitussives, bronchodilators, aerosol therapy, broad-spectrum antibiotics	Rarely fatal
Enteric protozoa *(e.g.*, *Giardia* spp., *Cystoisospora* spp., *Cryptosporidium* spp.)	All ages (more severe clinical signs in puppies)	Usually subclinical. Sometimes enteritis (watery or mucoid diarrhea, only occasionally with blood)	Antiprotozoal drugs	Rarely fatal

Viral infections in neonatal puppies

Among viruses, canine herpesvirus-1 (CaHV-1) and canine minute virus (CnMV), formerly known as canine parvovirus type 1, can be associated with systemic infection and mortality in newborn puppies. CaHV-1 causes different clinical signs according to the age of the infected dogs. In puppies and young adults, the virus may induce respiratory disease, while adult dogs may develop reproductive failures or genital infections. However, the most severe clinical form is observed in neonates, which develop a systemic disease characterized by abdominal pain, diarrhea, often hemorrhagic, serous or hemorrhagic nasal discharge, respiratory distress, neurological signs, and death. CnMV is only sporadically associated with neonatal death, causing enteritis, pneumonia, and myocarditis in 1-3-week-old puppies. Infected newborns usually cry incessantly and may display vomiting, diarrhea, respiratory distress, and sudden death.

The treatment of viral infections of neonate puppies is mainly supportive, requiring the administration of fluids and antibiotics, but is mostly unrewarding due to the rapidly fatal progression of the disease. Mortality can be reduced by adequate nutrition and elevating the environmental temperature. Administration of antiviral drugs, even for CaHV-1 infection, has been shown to be poorly effective.

Canine parvovirus infection

This is the most frequent infectious disease of puppies aged from 1 to 6 months. It is caused by canine parvovirus (CPV), a highly resistant virus in the environment, of which 3 variants (CPV-2a, CPV-2b, CPV-2c) are currently circulating in the field. The virus is shed in all body fluids, reaching very high titers in feces, and transmission takes places through the oronasal route. Puppies with parvoviral enteritis display lethargy, inappetence, fever (inconstant), vomiting, hemorrhagic diarrhea, dehydration, and death. Acute leukopenia (mainly lymphopenia) and regenerative anemia are the main hematological changes. Despite the extensive vaccination of dogs, CPV infection is still widespread due to the environmental persistence of the virus and maternal immunity interference with vaccination. No specific drug has been demonstrated to be really effective against CPV infection. Treatment of CPV enteritis is mainly supportive, aiming to restore fluids and electrolyte balance and to prevent concurrent infections by opportunistic bacteria.

Canine coronavirus infection

Canine coronavirus (CCoV) infection is frequent in puppies under 12 weeks of age. Two different viral genotypes are currently known, CCoV-I and CCoV-II, with the latter being subtyped into CCoV-IIa and CCoV-IIb. The virus has a fecal-oral route of transmission and is usually associated with mild to moderate enteric signs, including inappetence, depression, vomiting, and non-hemorrhagic diarrhea. The mortality rate is very low, and the puppies recover spontaneously. Hematological and biochemical

abnormalities are not commonly observed. Apart from the intestinal form, pantropic strains of CCoV have been reported, which are associated with systemic disease, lymphopenia, and death of the infected puppies. Treatment of CCoV enteric infection is only supportive and aims to maintain fluid and electrolyte balance.

Canine infectious hepatitis

Infectious canine hepatitis (ICH) is caused by canine adenovirus type 1 (CAdV-1), which is transmitted through contact with all body secretions from infected dogs. Shedding in urine has been demonstrated for 6-9 months. ICH may affect dogs of all ages, but young puppies develop the most severe clinical form. ICH is characterized by depression, fever, loss of appetite, diarrhea (sometimes hemorrhagic), vomiting, respiratory distress, ocular and nasal discharge, jaundice, and hemorrhages on the skin. Due to the formation of immune complexes, 10-15 days after the onset of clinical signs, puppies may display kidney injury and corneal edema (blue eye). Hematological findings include leukopenia, increased serum transaminases, and coagulation disorders associated with disseminated intravascular coagulation. Mortality is high even in adult dogs, but it can be reduced by proper supportive therapy based on the administration of fluids, plasma or whole blood transfusions, and anticoagulants. Specific drugs to treat kidney and hepatic failures are also required.

Canine distemper

Canine distemper virus (CDV) is poorly resistant in the environment and transmission takes place mainly through direct contact with infected dogs and their secretions. Clinical signs are related to virus replication in parenchymal tissues, but also the severe immunosuppression induced by CDV. Puppies affected by the most severe clinical forms display general clinical signs (fever, loss of appetite, lethargy), as well as enteric (vomiting, diarrhea), respiratory (mucopurulent nasal and ocular discharges, catarrhal bronchopneumonia), cutaneous (pyoderma), and neurological (ataxia, convulsions, paralysis) signs. Enamel hypoplasia and hyperkeratosis of the foot pads and nose are typical signs of CDV infection and may be observed in puppies that survive subclinical or subacute infections. Mortality rates are high, especially in juvenile dogs. Treatment consists of supportive care and antibiotics and is aimed at preventing secondary bacterial infections that are frequent in immunosuppressed animals. Antiviral drugs are not commercially available.

Canine infectious respiratory disease

Canine infectious respiratory disease (CIRD), formerly known as kennel cough, is typically a complex of diseases caused by viruses (canine adenovirus type 2, canine herpesvirus, canine parainfluenza and influenza viruses, canine respiratory coronavirus, canine pneumovirus) and bacteria *(Bordetella bronchiseptica*,

Mycoplasma cynos, *Streptococcus equi* subspp. *zooepidemicus).* Most frequently, a dry, hacking cough is observed as a consequence of uncomplicated, self-limiting, primarily viral infection of the trachea and bronchi. In complicated forms, more common in puppies, secondary bacterial infections may cause involvement of the lungs. Coughing is usually associated with mucoid discharges. The condition may progress to bronchopneumonia and, in the most severe instances, death, more commonly in puppies. Uncomplicated forms of CIRD can be treated with glucocorticoids, antitussives, and bronchodilators. Aerosol therapy can be effective in dogs displaying excessive accumulation of tracheal and bronchial secretions. Antimicrobial therapy is recommended in the complicated forms, especially in the presence of bacterial bronchopneumonia.

Infectious diseases in kittens (Table 2)

Bacterial infections in neonatal kittens

Bacterial infections are mostly responsible for kitten mortality within the first week of life, mainly through the development of septicemia, and can involve commonly isolated pathogens, such as *Staphylococcus* spp., *Streptococcus* spp., *Escherichia coli, Campylobacter* spp., and *Salmonella* spp. The environment and queens are suspected as the sources of infection (vaginal discharge, milk, feces, oropharynx, skin), similar to the situation in dogs. Clinical signs of septicemia in newborn kittens include navel illness, diarrhea, dyspnea, weight loss, anorexia, cyanosis, hypothermia, fever, and pyodermatitis. As with puppies, antibiotic treatment is more effective if amoxicillin-clavulanic acid or cephalosporins are used. Supportive treatment consists of the administration of fluids with a glucose solution, vitamins, or blood serum from healthy adults.

Feline panleukopenia

Feline panleukopenia is a highly contagious disease, caused by feline panleukopenia virus (FPV), which is closely related to CPV. The disease can affect cats of all ages, but it is more severe and fatal in young kittens. Cats are infected via the oronasal route as a consequence of direct and indirect contact with the feces or other secretions of infected animals. Clinical signs in kittens include depression, loss of appetite, high fever, vomiting, diarrhea, severe dehydration, and often death. The leukocyte counts are severely decreased in all their subsets (neutrophils and lymphocytes). Secondary infections can occur because of the severe impairment of the immune response. Perinatal infections lead to the development of a neurological syndrome, with signs of cerebellar ataxia and blindness. Supportive therapy and good nursing significantly decrease mortality rates. In addition, parenteral administration of broad-spectrum antimicrobials is helpful in preventing bacterial infections.

Table 2. **Infectious diseases in kittens.**

Etiology	Age	Clinical form(s)	Treatment	Outcome
Several bacterial species	< 3 weeks	Local infections, septicemia	Antibiotics (amoxicillin/ clavulanic acid, ampicillin, etc.)	Septicemic forms frequently fatal
Feline panleukopenia virus	More frequent in kittens < 6 months	Feline panleukopenia: hemorrhagic gastroenteritis, severe leukopenia, neurological signs in newborns	Supportive (fluid therapy, antibiotics against secondary infections)	Often fatal
Feline herpesvirus	More frequent in kittens < 6 months	Feline viral rhinotracheitis: rhinitis, conjunctivitis, keratitis, "fading kittens"	Supportive (fluid therapy, good nursing, antibiotics against secondary infections), antiviral drugs (famciclovir, topical cidofovir)	Sometimes fatal (secondary bacterial infections)
Feline calicivirus	More frequent in kittens < 6 months	Ulcerative upper respiratory tract disease, virulent systemic disease	Supportive (fluid therapy, antibiotics against secondary infections)	Sometimes fatal (virulent systemic disease)
Respiratory viruses and bacteria	All ages (more severe clinical signs in kittens)	Feline upper respiratory tract disease	Glucocorticoids, antitussives, bronchodilators, aerosol therapy, broad-spectrum antibiotics	Rarely fatal
Enteric protozoa *(e.g., Giardia* spp., *Cystoisospora* spp., *Cryptos-poridium* spp., *Tritrichomonas)*	All ages (more severe clinical signs in kittens)	Usually subclinical. Sometimes enteritis (watery or mucoid diarrhea, only occasionally with blood)	Antiprotozoal drugs	Rarely fatal

Feline viral rhinotracheitis

This disease is caused by feline herpesvirus-1 (FeHV-1), an alphaherpesvirus able to latently infect nervous ganglia after the primary infection. FeHV-1 is shed in ocular, nasal, and oral secretions. Transmission is largely by direct contact with a cat with acute or latent infection. Latently infected queens can transmit the infection to their offspring after viral reactivation due to the stress of parturition and lactation. FeHV-1 infection causes acute rhinitis and conjunctivitis, which are accompanied by fever, anorexia, lethargy, sneezing, and nasal and ocular discharge. Affected cats can display ulcerative, dendritic keratitis. Some animals may also develop systemic disease, with skin lesions (nasal and facial ulcerated and crusting lesions), severe systemic signs (depression, fever, anorexia), coughing, and death especially in newborns ("fading kittens"). Supportive therapy and good nursing are recommended along with broad-spectrum antibiotics to prevent secondary bacterial infections. Antiviral drugs such as famciclovir or topical cidofovir are effective mainly against the respiratory and ocular disease.

Feline calicivirus infection

Feline calicivirus (FCV) is responsible for different clinical forms according to the FCV strain involved, the host immune response, and any co-infections present. Infection can occur directly from cat to cat, indirectly via fomites, and possibly via aerosols. The most frequent clinical form is ulcerative upper respiratory tract disease, with oral ulcerations, gingivitis-stomatitis, fever, and lethargy. Less frequently, FCV can spread to the synovial membranes of joints causing a limping syndrome. However, the most severe form of FCV infection is the virulent-systemic disease (VSD), which is a consequence of a systemic inflammatory response with internal organ involvement, jaundice, disseminated intravascular coagulation, and severe skin and mucous membrane ulcerations. Treatment of FCV infection is supportive, consisting of the administration of fluids, anti-inflammatory drugs, feeding with highly palatable food, and antibiotics to prevent secondary bacterial infections. Antiviral drugs against FCV are not commercially available.

Feline upper respiratory tract disease

Upper respiratory tract disease (URTD) is a common cause of severe disease and sometimes death in kittens, especially in overcrowded environments. URTD results from a complex, multifactorial interaction of respiratory pathogens, stress, and animal susceptibility. The etiological agents include viruses and bacteria, acting either alone or synergically, including FCV, FeHV-1, *Mycoplasma felis, Bordetella bronchiseptica, Streptococcus* spp., and *Chlamydia felis.* Clinical signs may vary considerably in severity, including lethargy, inappetence, sneezing, conjunctival hyperemia, serous to mucopurulent nasal and ocular discharges, hypersalivation, and in some cases respiratory distress caused by bronchopneumonia and death. Treatment of viral URTD is largely supportive, whereas primary and secondary bacterial infections can be treated with antimicrobials. Antiviral drugs are emerging as treatment options in the case of FeHV-1 involvement.

Enteric protozoan diseases in puppies and kittens

Several enteric protozoa commonly infect puppies and kittens, including flagellates *(Giardia* and *Tritrichomonas)* and apicomplexa *(Cystoisospora, Cryptosporidium, Hammondia, Neospora, Toxoplasma,* and *Sarcocystis)*. Protozoan transmission occurs through the ingestion of oocysts or other protozoan forms that are present in contaminated feces, the environment, or carried by prey. Most of these protozoa have low pathogenicity, causing subclinical, self-limiting infections, but they can also induce severe enteritis, especially if associated with concurrent viral, bacterial, and helminth infections. Disease occurs most commonly in young animals living in overcrowded environments *(e.g.,* kennels, catteries, shelters, pet stores). Other factors influencing the clinical course are age, stress level, nutrition, immune status, and the load of protozoa. The most common sign of enteric protozoa infections is watery or mucoid diarrhea; only occasionally is there blood in the stool. The diarrhea may be acute or chronic, intermittent or continuous, and self-limiting or persistent. Anorexia, vomiting, weight loss, fever, and lethargy may be also seen. Acute toxoplasmosis and neosporosis are rare in cats and dogs, respectively, but kittens and puppies with prenatal infections can show severe clinical signs after birth, eventually dying.

Treatment of puppies and kittens with *Giardia* infection is based on the administration of antiprotozoal drugs, such as metronidazole or fenbendazole. Toltrazuril and diclazuril are currently the drugs of choice against cystoisosporosis, although coccidiostat products (sulfadimethoxine) are also used. There are no registered drugs against *Tritrichomonas* and *Cryptosporidium;* in cats, ronidazole has been used off-label against *Tritrichomonas fetus.* Neonates with clinical toxoplasmosis and neosporosis can be treated with clindamycin. *Hammondia* and *Sarcocystis* infections do not cause overt clinical signs in their natural hosts, so that treatment is not necessary.

ANTIMICROBIAL THERAPY BEST PRACTICES

Antimicrobials have been hailed as one of the most important medical advances of modern medicine and have saved and improved the lives of innumerable people and animals. However, their effectiveness and widespread availability come at a cost, including direct adverse effects of the drugs, impacts on the body's complex bacterial microbiota, and the "silent pandemic" of antimicrobial resistance. Antimicrobials are necessary in many situations, but they are also overused and misused, with potential negative consequences for the individual both in the short *(e.g.*, treatment failure, toxicity) and long *(e.g.*, microbiota disruption, antimicrobial resistance) terms.

Antimicrobial therapy in neonates and pediatric patients

The adage "a puppy is not just a small dog" applies to various aspects of antimicrobial therapy, including disease risks, administration issues, and the fate of drugs after administration. The approach to antimicrobial therapy in neonates is different from that for adults **(Table 1).**

Four main pharmacokinetic parameters must be considered: absorption, distribution, metabolism, and elimination. All can be different in neonates compared to adults and older puppies and kittens. These differences are also dynamic and can change rapidly as the individual ages during the first few weeks of life.

In the first 24 hours of life, oral absorption may be very high, resulting in unexpected and potentially unwanted bioavailability. Potentially toxic drugs that are not meant to be highly absorbed *(e.g.,* oral neomycin) should therefore be avoided in very young individuals. Nursing can impact the absorption of some drugs through binding by milk components and preventing the administration of a drug on an empty stomach. Slower gastric emptying can also impact absorption, delaying absorption but also potentially ultimately increasing bioavailability from longer mucosal contact. Relatively high gastric pH can decrease absorption of drugs that are weak acids *(e.g.*, fluoroquinolones). Therefore, there are competing factors that could increase or decrease oral bioavailability, making it difficult to predict the fate of some antimicrobials when specific data are not available.

Table 1. Potential dosing approaches for young puppies and kittens.

Drug	Adult dose	Puppy/kitten considerations
Amikacin	10-15 (cats) or 15-30 (dogs) mg/kg IV/IM/QC q24h	Greater distribution. Reduced renal elimination. Oto- and nephrotoxicity. Variable dosing recommendations in human infants. Consider extending dosing interval for young puppies/ kittens. Therapeutic drug monitoring is ideal. Reserve for serious infections.
Amoxicillin	11-20 mg/kg PO q8-12h	Greater distribution and wide margin of safety. Wide dosing range in human infants. 20-50 mg/kg q12h. Dosing at higher intervals (q8h) and lower doses should be considered in older (> 1 month) individuals.
Amoxicillin + clavulanic acid	12.5-20 mg/kg PO q12h	Little is known about clavulanic acid pharmacokinetics. 15 mg/kg POq12h has been recommended in humans, despite typical use of higher doses of amoxicillin. Given potential adverse effects from clavulanic acid, lower doses than for amoxicillin alone are reasonable *(e.g.,* 15-20 mg/kg POq12h).
Ampicillin	20-40 mg/kg IV q4-8h	Greater distribution. Wide margin of safety. 50 mg/kg IV q4-6h. Higher doses may be appropriate in some situations.
Ceftiofur sodium	2.2 mg/kg IV, IM, SC q12-24h	2.5 mg/kg SC q12h. Ceftiofur crystalline free acid should be avoided because the pharmacokinetics of this sustained release formulation are unknown in young puppies /kittens.
Cephalexin	22-30 mg/kg PO q12h	High end of the adult dosing range is probably ideal.
Cefotaxime	40-50 mg/kg IV/SC/IM q8h	Good choice for broad spectrum systemic coverage in critically ill patients. High end of adult dosing range is probably appropriate. Consider prolonged dosing interval (q12h) in animals < 1 week of age.
Clindamycin	10-15 mg/kg PO/IV q12h	Adult doses are likely appropriate. Low end of dosing range should be considered in very young (< 1 week) animals.
Doxycycline	5-10 mg/kg PO/IV q12-24h	Tooth staining is not a concern. Regular adult doses are appropriate.
Fluoro-quinolones	Various	Greater distribution and variable renal elimination. Adult dosage ranges are likely appropriate but low oral bioavailability was reported for enrofloxacin in 6-8 week old kittens so there can be limited confidence in dosing. Low end of adult dosage may be best for very young (< 1 week) individuals. Avoid in growing animals unless necessary. Short term use at regular doses probably poses limited risk but risk of arthropathy or tendinopathy remains. Avoid enrofloxacin in kittens because of retinopathy.

From Scott Weese J. Antimicrobial use in puppies and kittens. *Vet Focus* 2022.

However, some examples are available, such as the failure of oral administration of enrofloxacin to produce therapeutic drug levels in nursing (6-8-week-old) kittens.

Distribution can be markedly altered because neonates have a larger fraction of extracellular fluid, up to twice as large as adults, along with less adipose tissue and muscle, resulting in increased distribution of water-soluble drugs *(e.g.,* penicillins, cephalosporins, aminoglycosides) and correspondingly lower tissue levels. Lower serum protein concentrations and a lower affinity of protein binding in neonates may increase free (active) drug levels of highly protein bound drugs *(e.g.,* cefovecin) and increase the rate of elimination and corresponding dosing interval.

Metabolism may be delayed by reduced hepatic enzymatic activity, particularly in the first 4 weeks of life. Renal excretion may also be reduced but can be variable. Renal and hepatic function likely approach adult levels by 4-6 weeks of age; however, until that point, there can be an increased risk of toxicity.

Impact of antimicrobials on the commensal microbiota

From the moment of birth, the body encounters a diverse microbiological world and it must establish a commensal relationship with countless bacteria. Neonates are exposed to the dam's microbiota from her vagina, skin, milk, respiratory tract, and intestinal tract, as well as the microbiota from the environment, human handlers, and any other contacts. These early exposures shape the development of the microbiota and can have long-lasting impacts. For example, in humans, babies born by C-section develop a microbiota that is different from those born vaginally, and these changes can persist for months. As the body and its microbiota develop in parallel, the immune system must learn to tolerate microbial exposure while developing and maintaining the ability to appropriately respond to pathogenic microbes. Failure to adequately tolerate the body's commensal antigenic burden can lead to immune mediated disease, while inadequate responses create a risk from life-threatening infections. The bacterial microbiota is a critical component of immune development and is required for proper development of the immune system. However, alterations in the microbiota can alter the development of the immune system and increase the risk of disease.

A profound influencer of the microbiota is antimicrobial treatment. These impacts can persist well beyond the period of treatment and antimicrobial therapy can disrupt the vital development of the commensal microbiota and influence its complex interactions with the body. In humans, the use of antibiotics in infants has been associated with an increased risk of asthma, linked to changes in the gut microbiota. Other studies have also reported associations between antimicrobial use in children and subsequent risk of allergic diseases, including asthma, atopy, and food allergy. While this has not been studied yet in dogs and cats, it is reasonable to suspect that changes in the gut microbiota from early antimicrobial use could similarly impact the risk of immunologically-mediated diseases such as atopy and food allergy. Antimicrobial use in the mother during pregnancy can also impact the neonatal microbiota in humans and is associated with an increased risk of allergic disease in the baby. While antimicrobials are necessary for the treatment of bacterial diseases, these concerns highlight the need for antimicrobial stewardship to ensure that the poorly understood but real risks from treatment are outweighed by the need for antimicrobials.

Antimicrobial resistance

Any antimicrobial exposure creates some pressure for the emergence or dissemination of resistance. The more exposure, both in terms of the number of treatment courses and the duration of treatment, the greater the general risk. This is of particular concern for breeders, as frequent use of antimicrobials can lead to the accumulation of high rates of resistance in important bacteria such as *Staphylococcus pseudintermedius.* While resistant bacteria are not more inherently virulent than their susceptible counterparts, if antimicrobial resistant bacteria accumulate in individual animals and the facility as a whole, over time the risk of treatment failures increases when bacterial diseases develop. Antimicrobial stewardship is emerging as an important field that aims to reduce the need for antimicrobials, while fostering optimal use practices when antimicrobials are necessary.

Antimicrobials should be avoided when not clearly indicated and neonatal dosing differences should be taken into account when antimicrobials are required to maximize the benefits and minimize the risks. This can presumably have long-lasting benefits on puppy and kitten health through minimizing the need for antimicrobials.

ANESTHESIA AND PAIN MANAGEMENT IN PUPPIES AND KITTENS

Age is an important risk factor in anesthesia-induced mortality in small animals. Puppies and kittens are often at an increased risk of anesthetic mortality, particularly for those with coexisting diseases, poor physical status, and those undergoing emergency procedures. Neonates and juvenile animals (before reproductive maturity) have significant physiological differences from adults, with an important impact on anesthetic management.

Pharmacokinetic and pharmacodynamic differences

Any anesthetic plan should consider the pharmacokinetic and pharmacodynamic differences between adults and neonates/juveniles, as drug uptake, distribution, metabolism, and excretion can be significantly different.

- Puppies and kittens have low albumin levels which, in theory, may lead to decreased protein binding facilitating drug overdosing *(i.e.,* a larger free fraction of anesthetics is available for a biological effect).
- The blood brain-barrier is often less selective to different molecules which could also exacerbate drug effects. Short-acting drugs should be titrated to effect wherever possible.
- For the aforementioned reasons, low doses of anesthetics and analgesics should be used in young patients.
- Another important difference between adult and young animals is the percentage of body water content. Young patients have a higher body water content leading to an increased volume of drug distribution for water-soluble agents (but less for lipid-soluble drugs).

The anesthetic plan

The anesthetic plan for neonates and juveniles should focus on the patient's condition based on history and physical/laboratory examination. However, attention should be given to how disease, procedure, physical status, and drug protocols will affect the physiological systems of the neonate/juvenile patient, considering the differences described above and in **Table 1.**

- Dehydrated and hypovolemic individuals should be stabilized prior to anesthesia; this will decrease anesthetic complications as well as the risk of morbidity and mortality.
- Good practice also involves fluid therapy using a balanced, isotonic, crystalloid solution with or without 2.5% dextrose as required taking into account ongoing losses, maintenance requirements, and dehydration.
- These patients are at greater risk of hypoventilation, hypotension, hypothermia, and hypoxemia (the four "H's") than adult patients. Anesthetic monitoring and appropriate drug choices are crucial to prevent these complications.
- Glucose levels and body temperature should be monitored closely. Indeed, the patient's temperature should be supported throughout the procedure.
- Patients with congenital cardiac disease should probably be referred for a "work-up" by a cardiologist. A specialist in anesthesia and analgesia is recommended for high-risk cases and procedures involving the cardiovascular system.

Remember that neonates and juveniles are at higher risk of

Hypoventilation

Hypotension

Hypothermia

Hypoxemia

Table 1. The most important physiological changes in neonates and juveniles and how they can affect anesthetic management. Most data are extrapolated from studies in human pediatrics and in the experimental setting.

System	Physiological changes	Effects on anesthetic management
Cardiovascular	• Cardiac output highly dependent on heart rate and less on stroke volume • Baroreceptors are not fully matured • Minimal ability to produce changes in vascular tone • Attention to potential congenital heart disease on auscultation	• Greater risk of hypotension, especially with dehydration and hypovolemia • Anticholinergics may be used to maintain acceptable heart rate and cardiac output while avoiding bradycardia
Respiratory	• Weak intercostal muscles • Great respiratory compliance • Chemoreceptors are not fully matured: poor response to hypercapnia or hypoxemia (neonates) • ↓ Functional residual capacity	• Greater risk of hypoventilation (respiratory fatigue), hypercapnia, and hypoxemia during anesthesia • Preoxygenation strongly recommended before anesthetic induction; oxygenation recommended during early anesthetic recovery • Adjust ventilation accordingly; capnography allows detection of hypoventilation and hypercapnia
Hepatic	• Cytochrome P450 is not fully developed: ↓drug metabolism and excretion • Limited glycogen stores and gluconeogenic capacity	• Use short-acting drugs that can be potentially antagonized • Expect prolonged recoveries in some cases • Hypoglycemia is a major concern; glucose levels should be checked periodically, or at least before and after anesthesia
Central nervous system (CNS)	• Changes in number, type, and density of receptors across the CNS • Thermoregulatory center is sensitive in addition to greater body-surface area and less subcutaneous fat; shivering is often not effective	• Low doses or "give to effect" must be considered; dose adjustment required • Great risk of hypothermia leading to dysrhythmias, reduced anesthetic requirements, prolonged anesthetic recovery
Renal	• Nephrogenesis is not complete until 6-8 weeks of age: limited glomerular filtration, tubule sodium excretion, urine concentrating ability, and drug excretion capacity	• Greater risk of dehydration and prolonged drug effects • Changes in electrolyte and acid-base disturbances • Blood pressure monitoring is important to ensure normal renal blood flow

Anesthetic protocol

- Sedation and analgesia in young animals can be accomplished with a combination of an opioid (buprenorphine 0.02 mg/kg or methadone 0.2 mg/kg) and midazolam (0.3 mg/kg) intramuscularly. A low dose of an opioid alone can be used for analgesia in neonates with careful titration to avoid respiratory depression. In the event of significant adverse effects, naloxone can be used to antagonize the effects of opioids; however, analgesia will be also reversed.
- Anticholinergics can be added to the premedication as these drugs increase heart rate and support blood pressure.
- In general, agonists of alpha-2 adrenergic receptors (medetomidine or dexmedetomidine) are avoided for sedation in neonates as they can produce bradycardia and substantial decreases in cardiac output. On the other hand, these drugs are often combined with ketamine and opioids during neutering of young patients older than 2 months of age and are well tolerated.
- After preoxygenation, neonates can be induced with a tight face mask using sevoflurane depending on the patient's condition.
- The slow intravenous administration of low doses of propofol (2-4 mg/kg) or alfaxalone (1-2 mg/kg) "to effect" can be used as alternatives, especially in young animals. The slower the administration, the less likelihood of apnea and respiratory depression with these drugs.
- Endotracheal intubation can be difficult in very young puppies and kittens; careful intubation is a must as their airways are small and fragile and can be easily traumatized.

- In cats, the volume of lidocaine required for desensitization of the arytenoids should be calculated to avoid local anesthetic toxicity in neonates.
- If assisted ventilation is required, it should be performed with care as barotrauma could easily occur due to the fragility of the respiratory tract, especially when respiratory disease *(e.g.,* pneumonia) is present.
- Anesthetic maintenance is usually performed with isoflurane or sevoflurane as injectable anesthetics may accumulate and prolong recovery. However, as previously mentioned, alpha-2 adrenergic receptor agonists can be used in animals over 2 months of age.
- Anesthetic recovery should be closely monitored as complications can occur including the "four H's" at least 3 hours after extubation. During this period, anesthetic mortality is increased in both dogs and cats.
- Patients should be offered a small meal to avoid hypoglycemia once they are bright, alert, and responsive in sternal recumbency and able to protect their airways.

Pain management

Neonates and juveniles have the same ability to perceive pain as adults because their nociceptive pathways are already mature at the time of birth **(Figure 1).**

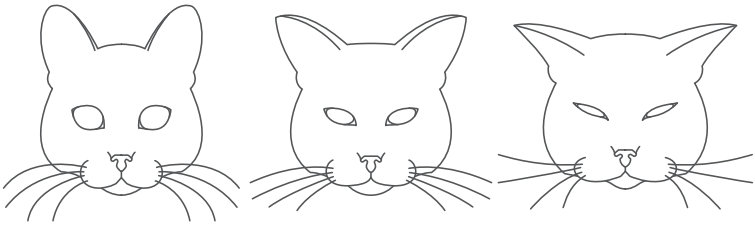


Figure 1. Facial expressions in cats with pain intensity increasing from left to right.

- Pain scoring systems should be used for pain assessment. The Feline Grimace Scale has been validated for kittens.
- A fact sheet, training materials, and a phone app are available on the website: www.felinegrimacescale.com
- Opioid dosage regimens should be adjusted in juveniles. For example, a recent study suggested that the duration and magnitude of analgesia with hydromorphone is shorter and smaller, respectively, in kittens 6 months of age when compared with those 9-12 months of age. It seems that, at least in kittens, more frequent dosing of opioids is required for analgesia as compared to adult cats.
- Local anesthetic blocks can be used in puppies and kittens and should be incorporated as part of multimodal analgesia and in neutering programs. Suggested maximum doses of lidocaine (6 mg/kg) or bupivacaine (2 mg/kg) should be calculated before injection to avoid local anesthetic toxicity. These may include the intratesticular, intraperitoneal, and incisional local blocks. Videos for these techniques can be seen using the following links:
  - Incisional anesthesia
    https://www.youtube.com/watch?v=43Km46WJ2zI
  - Intraperitoneal anesthesia
    https://www.youtube.com/watch?v=eLa1UxWboh0
  - Intratesticular anesthesia
    https://www.youtube.com/watch?v=VHfqoUPse-c
- Nonsteroidal anti-inflammatory drugs (NSAIDs) can be administered in juveniles without contraindications when they are > 12-16 weeks of age. However, some studies have reported the administration of NSAIDs to kittens 10-12 weeks of age without reported adverse events. A single dose of NSAIDs postoperatively when the patient is recovering from anesthesia is beneficial in neutering programs.

APPENDIX

BLOOD PARAMETERS REFERENCE VALUES IN PUPPIES

Biochemistry

0 to 8 weeks									
Parameter (usual reference values)	0	1	2	3	4	5	6	7	8
Urea (0.2-0.5 g/L)	0.59-1.01	0.42-0.6	0.29-0.43	0.24-0.36	0.14-0.24	0.2-0.36	0.34-0.44	0.28-0.48	0.22-0.36
Creatinine (0.6-1.5 mg/dL)	0.71	0.33-0.63	0.26-0.54	0.3-0.5	0.36-0.56	0.34-0.62	0.4-0.66	0.49-0.71	0.4-0.7
PAL (< 80 IU/L)	3,097-7,125	557-1,263	405-781	352-584	134-740	322-760	224-552	316-524	357-643
ALAT (<60 IU/L)	19-67	8-28	6-14	4-18	7-13	5-19	10-14	13-25	20-32
Glucose (70-150 mg/dL)	86-126	107-137	101-131	73-125	110-142	98-124	82-100	108-126	112-128
Total protein (60-75 g/L)	32-46	26-42	27-39	31-39	22-38	35-45	39-43	37-41	42-50
CK (< 150 IU/L)	633-3,565	364-1,074	314-722	486-1,010	291-587	232-420	484-670	261-323	304-594
Bilirubin (3-5 mg/kg/d)	< 25	< 33	< 33	< 3	< 21	0	23-61	3-33	8-14
Bile acids (µmol/L)	-	-	-	-			< 15		
Albumin (g/dL)	-	-	-	-		4-5		2-3	
Na (mEq/L)	-	-	-	-			148		
Cl (mEq/L)	-	-	-	-			105		
K (mEq/L)	-	-	-	-			5		
Ca (mEq/L)	-	-	-	-			11		
Cholesterol (mg/dL)	-	-	-	-	-	-		111-258	

2 to 6 months		
	2-3 months	4-6 months
Albumin (g/dL)	2.6-3.7	2.6-3.7
PAL (U/L)	88-532	126-438
ALT (U/L)	< 29	< 32
Amylase (U/L)	< 1,683	< 1,683
ASAT (U/L)	7-19	3-23
Bilirubin (mg/ dL)	0.01-0.13	0.01-0.13
Urea (mg/dL)	9.8-37.3	9.8-37.3
Calcium (mg/ dL)	10.4-13.6	10-13.2
Chloride (mEq/L)	99-120	99-120
Cholesterol (mg/dL)	99.6-499.6	135-278
CK (U/L)	31-255	40-192
Creatinine (mg/dL)	0.39-0.49	0.27-0.88
GGT (U/L)	< 6.2	< 4.3
Globulin (g/dL)	1.9-2.5	2.2-3.5
Glucose (mg/dL)	97.1-166.2	97.1-166.2
GLDH (U/L)	1.6-9.6	1.9-8.7
LDH (U/L)	68-290	< 442
Lipase (U/L)	< 241	< 139
Magnesium (mEq/L)	1.4-5.2	1.4-5.2
Phosphorus (mg/dL)	6.4-11.3	5.6-9.6
Potassium (mEq/L)	4.5-6.3	3.9-6.1
Sodium (mEq/L)	140-156	139-159
Total protein (g/dL)	4.3-5.8	4.5-7.3
Triglycerides (mg/dL)	19.1-205.5	19.1-205.5
TLI (ng/L)	5-35	

From Lévy X, *et al.* Guide pratique de Pédiatrie canine et féline. *Editions Med'Com* 2016.

Hematology

0 to 8 weeks									
Parameters (usual adult values)	0	1	2	3	4	5	6	7	8
Ht (38-57)	40.4-52.6	34.3-41.7	28-31.6	25.4-29.8	26.7-29.7	23.6-28	25.2-27.8	27.9-33.5	27.7-33.7
RBC (5.5-8.5 10^6/mL)	4.6-5.8	4.3-4.9	3.5-4.1	3.4-4	3.9-4.3	3.7-4.1	3.8-4.2	4.3-4.9	4.4-5
Hb (13.2-19.2 g/dL)	13.3-17.3	11-14	9.5-10.3	8.4-10	8.5-9.7	7.4-9.6	8.2-10.2	8.9-10.5	9.5-11.1
GMV (62-71 fL)	85-93	77-87	76-82	71-77	67-71	65-69	65-69	63-71	63-69
MCHT (19-25 pg)	27.6-30.4	24.5-29.5	24-28	22.7-27.3	20.3-23.7	20.4-25.6	20.4-25.6	19.8-22.2	20.1-23.9
MCHF (32-66%)	32.4-33.6	31.5-34.5	31.6-34.4	31-35	30.3-33.7	32.1-37.9	32.1-37.9	31.4-32.6	31.3-34.7
Reticulocytes (<2%)	7-21	< 15	3-15	4-10	3-11	6-16	6-16	8-18	2-6
PQT (200-500 10^3/mL)	286-416	359-615	351-509	271-481	308-518	265-447	206-514	196-478	215-551
VMP (7.6-8.3 fL)	7.2-8.8	9-11	9.4-10.6	10-12	9.9-12.1	9.9-12.1	10.1-11.9	10.4-11.6	10.3-11.7
Total WBC (6.6-17.4 10^3/mL)	12.9-21.1	11.1-18.9	7.8-11.7	9-12.8	10.2-17.2	11.5-18.9	12.9-18.7	14-20.2	12.3-21.9

12- to 24-weeks-old				
Parameters	12 w	16 w	20 w	24 w
RBC (10^6/mL)	6.34	6.38	6.93	7.4
Hb (g/dL)	14.3	15	16	16.7
VGM (fL)	64.6	67.4	64.8	64.2
MCHT (pg)	22.8	23.5	23	22.5
CCMH (%)	35.3	34.8	35.6	35.1
Total WBC (10^3/mL)	17.1	16.3	14.6	15.6

BLOOD PARAMETERS REFERENCE VALUES IN KITTENS

Biochemistry

0 to 8 weeks					
	D0	D1	D7	D28	D56
Albumin (g/dL)	2.5-3	1.9-2.7	2-2.5	2.4-4.9	2.4-3
PAL (U/L)	184-538	1,348-3,715	126-363	97-274	60-161
ALT (U/L)	7-42	29-77	11-76	14-55	12-56
Amylase (U/L)	310-837	310-659	187-438	275-677	407-856
ASAT (U/L)	21-126	75-263	15-45	15-31	14-40
Bilirubin (mg/dL)	0.1-1.1	0.1-1.6	0-0.6	0-0.3	0-0.1
Urea (mg/dL)	26-45	34-94	16-36	10-22	16-33
Calcium (mg/ dL)	9.4-13.9	9.6-12.2	10-13.7	10-12.2	9.8-11.7
Cholesterol (mg/dL)	65-141	48-212	119-213	173-253	124-221
CK (U/L)	91-2,300	519-2,654	107-445	125-592	102-1,512
Creatinine (mg/dL)	1.2-3.1	0.6-1.2	0.3-0.7	0.4-0.7	0.6-1.2
GGT (U/L)	0-2	0-9	0-5	0-1	0-2
Glucose (mg/dL)	55-290	65-149	105-145	117-152	94-143
LDH (U/L)	176-1,525	302-1,309	117-513	98-410	65-862
Lipase (U/L)	12-43	21-131	8-46	4-86	6-70
Phosphorus (mg/dL)	5.9-11.2	4.9-8.9	6.7-11	6.7-9	7.6-11.7
Total protein (g/dL)	3.8-5.2	3.9-5.8	3.5-4.8	4.5-5.7	4.8-6.5
Triglycerides (mg/dL)	23-132	30-644	129-963	43-271	16-170

2 to 6 months		
	2-3 months	4-6 months
PAL (U/L)	10-50	< 77
ALT (U/L)	< 564	37-333
Amylase (U/L)	< 1,800	1,800
ASAT (U/L)	< 20	< 30
Bilirubin (mg/dL)	< 4	< 4
Urea (mg/dL)	17-35	17-35
Calcium (mg/ dL)	9.2-12	9.2-12
Chloride (mEq/L)	97-125	102-122
CK (U/L)	< 188	< 160
Creatinine (mg/dL)	0.16-1.26	0.33-1.21
GGT (U/L)	< 4	< 4
Glucose (mg/dL)	70-150	70-150
GLDH (U/L)	< 7	< 7
LDH (U/L)	68-280	<442
Lipase (U/L)	< 280	< 280
Magnesium (mEq/L)	1.2-5.2	1.2-5.2
Phosphorus (mg/dL)	6.5-10.1	6-10.4
Potassium (mEq/L)	3.7-6.1	4.2-5.8
Sodium (mEq/L)	143-160	143-160
Total protein (g/dL)	-	3.3-7.5
TLI (ng/L)	17-49	

From Lévy X, *et al.* Guide pratique de Pédiatrie canine et féline. *Editions Med'Com* 2016.

Hematology

0- to 24-weeks-old								
Parameters (usual adult values)	0-2	2-4	4-6	6-8	8-9	12-13	16-17	20
RBC (10^6/mL)	5.29±0.24	4.67±0.10	5.89±0.23	6.57±0.26	6.95	7.4	8.1±0.27	7.4
Hb (g/dL)	12.1±0.6	8.7±0.2	8.6±0.3	9.1±0.3	9.8	10.1	11±0.4	10.7
VGM (fL)	67.4±1.9	53.9±1.2	745.7±1.3	45.6±1	47.8	44.5	43.1±1.5	45
MCHT (pg)	23±0.6	18.8±0.8	14.8±0.6	13.9±0.3	14.1	13.7	13.5±0.4	_
MCHF (%)	34.5±0.8	33±0.5	31.9±0.6	30.9±0.5	29.5	31.3	31.6	32
Total WBC (10^3/mL)	9.67±0.57	15.3±1.2	17.4±1.4	18±2	23.7	23.2	19.7	16

FECAL SCORING SYSTEM

FOR MINI AND MEDIUM PUPPIES
FOR MAXI AND GIANT PUPPIES
FOR CATS

GASTROINTESTINAL TRACT

FECAL SCORING SYSTEM
FOR MINI & MEDIUM PUPPIES

DIRECTIONS FOR USE

Score stools individually **from 1 (formed and dry) to 5 (liquid)**.
When consistency of the stools is not homogenous, record the higher score.

TOO HARD / TOO SOFT | ACCEPTABLE | OPTIMAL

1

FORMED, DRY AND HARD FECES

2

FORMED, DRY BUT NOT HARD FECES

Cylindrical shape feces, dry appearance, separated in pellets. Harder ones can be deformed with some difficulty (fig. II) or more easily (fig. III).

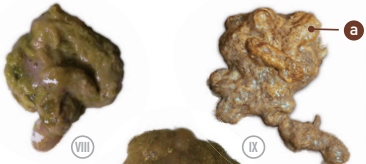
SOFTER ONES ARE SLIGHTLY STICKY (fig. IV)

2.5

SOFT FORMED FECES

Formed but very soft feces. Cylindrical shape separated in pellets (fig. V) or with presence of stria (fig. VI). Softer ones are pasty, still cylindrical shape but no stria (fig. VII).

3



4

SOFT UNFORMED FECES

Feces mainly unformed with a small formed part (fig. VIII) or pasty unformed feces (fig. IX & X). In some cases (fig. IX) a cylindrical shape is visible (a), but is not maintained due to the high humidity.

IF 7 WEEKS OLD OR LESS
VIII IX X

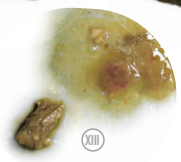
IF 8 WEEKS OLD OR MORE
VIII IX X

4.5

LIQUID FECES ASSOCIATED WITH SOFT FECES

The main part of the feces is represented by soft (fig. XI) or liquid (fig. XII) feces.

5



LIQUID FECES (fig. XIII)

GASTROINTESTINAL TRACT

FECAL SCORING SYSTEM
FOR MAXI & GIANT PUPPIES

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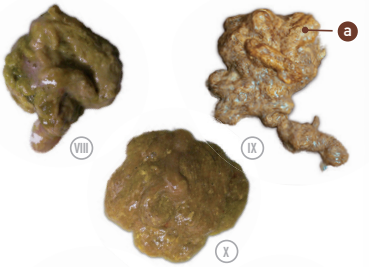


SOFT UNFORMED FECES

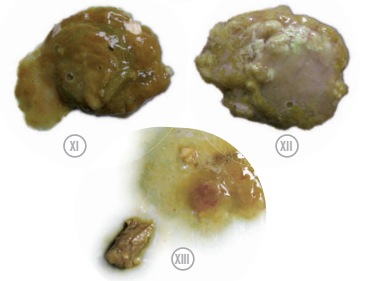
Feces mainly unformed with a small formed part (fig. VIII) or pasty unformed feces (fig. IX & X). In some cases (fig. IX) a cylindrical shape is visible (a), but is not maintained due to the high humidity.

IF 7 WEEKS OLD OR LESS
VIII IX X

IF 8 WEEKS OLD OR MORE
VIII IX X

4.5

5



LIQUID FECES ASSOCIATED WITH SOFT FECES

The main part of the feces is represented by soft (fig. XI) or liquid (fig. XII) feces.

LIQUID FECES (fig. XIII)

GASTROINTESTINAL TRACT

FECAL SCORING SYSTEM FOR CATS

DIRECTIONS FOR USE Score stools individually **from 1 (formed and dry) to 5 (liquid)**. When consistency of the stools is not homogenous, record the higher score.

TOO HARD / TOO SOFT | ACCEPTABLE | OPTIMAL

1

HARD, DRY, CRUMBLY STOOL (crumbs)

Crushing the stool with a fork leaves no mark on it.
It tends to split apart rather than being crushed.
Looks like crumble topping.

2

FORMED, HARD STOOL

This stool has very clearly defined cracks. The outside is very dry and the inside is almost dry (unlike the ***score 2.5*** stool, which is softer).
When you press down on it with a fork, separate little pieces break off along the cracks. Leaves no residue on the ground when picked up.

2.5

FORMED, FIRM STOOL

This stool has a clearly defined shape with visible cracks.
Its surface may be slightly damp but is still well formed.
When you press down on it with a fork, the stool is crushed, although you will feel some resistance, unlike the ***score 3*** stool.
It leaves very little residue on the ground when picked up.

3

UNFORMED STOOL, SOFT BUT WITH SOME SHAPE

A moist stool with no cracks.
It still has a distinct shape when compared to the ***score 4*** stool.
This stool's different "components" stick to one another.
Leaves residue on the ground when picked up.

4

VERY SOFT STOOL

Very wet, but not liquid stool. When compared to the ***score 5*** stool, this stool retains the water that is nevertheless visible between its different constituent parts.

5

LIQUID STOOL

Entirely liquid stool (no texture)
or liquid stool with minimal consistency.

INDEX

Puppies and kittens are a population that benefits more than others from early care and preventive actions that enable them to live longer, healthier lives.

The ambition of this handbook is to help veterinary practitioners feel confident starting or developing neonatal and pediatric consultations – for healthy and sick puppies and kittens. It can be used during the consultation for a quick check-up, but also between consultations for a deep dive.

Throughout the chapters, the authors have endeavored to highlight the specificities of these population in terms of physiology, diseases, treatments and care, and to provide advice that will enable veterinary clinic staff to help breeders and pet owners in their quest for a healthy pet.

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