NEONATOLOGY
PRACTICAL GUIDE FOR
FELINE AND CANINE
BREEDERS

THE FIRST THREE WEEKS OF LIFE

A CRITICAL TIME FOR PUPPIES AND KITTENS

ROYAL CANIN®

INCREDIBLE IN EVERY DETAIL

CONTRIBUTORS

Sylvie CHASTANT-MAILLARD

Professor of reproduction. NeoCare (Neonatalogy of Carnivores, Reproduction and Breeding). Toulouse national veterinary school, Toulouse, France. DVM, PhD, graduate of the European College of Animal Reproduction.

Sylvie Chastant-Maillard graduated from Alfort National Veterinary School (Paris, France) with a veterinary diploma in 1990 and taught reproduction there until 2010. After a PhD (on mammalian pre-implantation embryos) in 1995, she funded a scientific laboratory at Alfort dedicated to canine and feline reproductive biotechnology (especially in vitro maturation and fertilization). Sylvie Chastant-Maillard is also qualified at the European College for Animal Reproduction. She is currently a full Professor in Reproduction at Toulouse National Veterinary School (France), where she teaches small animal reproduction and develops research on canine neonatology and pediatrics.

Alain FONTBONNE

Associate professor of reproduction. CERCA (research centre for reproduction in carnivores), Alfort national veterinary school, Paris, France. DVM, PhD, graduate of the European College of Animal Reproduction.

Graduating from the Nantes Veterinary School in 1985, Alain Fontbonne continued his studies at the Alfort Veterinary School (Paris) as trainee Vet in the domestic carnivore unit. In 1993, he was appointed Conference Master at the Lyons Veterinary School, where he created a clinical research unit on the reproduction and the rearing of domestic carnivores. In 2000, he returned to the Alfort Veterinary School where he is now not only Head of the animal gynaecology-obstetrics division, but also in charge of the Centre d'Etude en Reproduction des Carnivores (CERCA) [Research Centre for Reproduction in Carnivores], a unit specialising in pet breeding assistance. Alain Fontbonne also qualified at the European College for Animal Reproduction and is former President of the European Veterinary Society for Small Animal Reproduction (EVSSAR). He has written several books for breeders and veterinarians.

Aurélie FOURNIER

Hospital practitioner. NeoCare. Toulouse national veterinary school, Toulouse, France. DVM, PhD student.

Aurélie Fournier graduated from Alfort National Veterinary School (Paris, France) in 2011, and specialized in small animal medicine and surgery during a one-year internship at VetAgroSup (Lyon, France). After 3 years in private practice (mainly the Veterinary Hospital of Reims, France), she joined NeoCare Center as a PhD student to investigate kitten infectiology and metabolism. Her research interests are feline neonatology and pediatrics, with a focus on the influence of colostrum and milk quality on kitten health.

Aurélien GRELLET

Research engineer. NeoCare. Toulouse national veterinary school, Toulouse, France. DVM, PhD.

Aurelien Grellet graduated with a veterinary diploma from Liege veterinary school (Liege, Belgium). After his internship at the same vet school, he spent five years at Alfort Veterinary School (Paris, France), where he was in charge of the canine and feline breeding department. In 2012, he obtained his PhD degree, with a project on the risk factors for weaning diarrhea in puppies. Between 2011 and 2016, he collaborated with Royal Canin in the Research and Development department (scientific communication). Aurelien Grellet joined NeoCare Center in 2016. His research focuses are canine and feline pediatrics, and in particular the influence of infectious diseases on digestive health during the weaning period.

Hanna MILA

Research engineer. NeoCare. Toulouse national veterinary school, Toulouse, France. DVM, PhD. Resident at the European College of Animal Reproduction.

Hanna Mila graduated from Wrocław Veterinary Faculty (Poland, 2009), where she worked for two years at the Clinic for Small Animal Reproduction. In 2012, she joined NeoCare Center. In September 2015, she obtained her PhD degree with a research project on immunological and nutritional determinants of survival in puppies. Today, Hanna Mila is following a residency program at the European College of Animal Reproduction, with a sub-specialty in small animal reproduction at the ENVT. Her research focuses on canine neonatology and pediatrics, and in particular on the influence of growth during the foetal period and the first weeks of life on puppy health, as well as the influence of colostrum and milk quality and intake on health.

Andréa MUNNICH

Practitioner. Bernau, Germany. DVM, graduate from the European College of Animal Reproduction. Previously, associate professor at the Berlin veterinary faculty (Freie University), Germany.

Dr Andrea Munnich is graduated from Humboldt University's Veterinary in Berlin, Germany. From 1988 to 1993, she held the position of assistant teacher at the clinic of obstetrics and reproductive problems, and obtained her PhD in 1991. In 1993, Andrea Münnich was Assistant Professor at the reproductive clinic at the Freie Universität Veterinary Faculty in Berlin. A graduate of the European College of Animal Reproduction, she is also author and co-author of a number of works on reproduction. Since 2006, she has been practising her speciality in reproduction at her own clinic in Bernau, Germany, and is regularly involved in training students and veterinarians in animal reproduction.

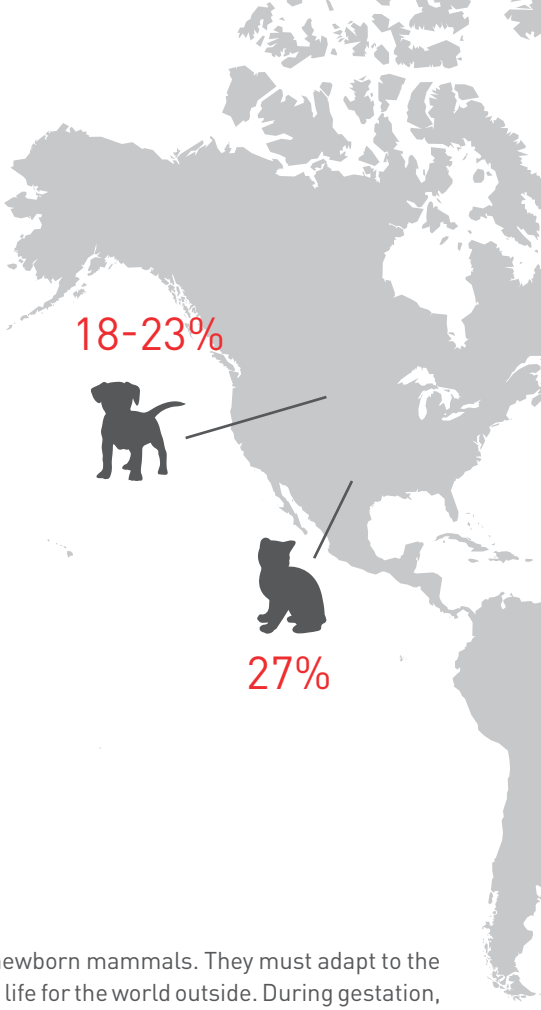
Acknowledgements

We would like to thank the many veterinary students, who are now doctors, who shared our enthusiasm and interest in the exploration of carnivore neonatalogy: Charlotte AGGOUNI, Amélie ALBARET, Jennifer ANNE, Marion BELIN, Marie-Blanche BERTIERI, Joanna BOURCIER, Diane BROUSSOU, Marie CATTEAU, Stéphanie COINUS, Marine DEBOUCHAUD Marine DELEBARRE, Anne-Laure ERBACHER, Leslie GARRIER, Mylène GONNIER, Clémence GUILLEMOT, Sarah JOUGNEAU, Emma LAVERGNE, Alice LE GAL, Morgane MANTELLI, Marine MASSON, Cynthia OLIVIER, Laurène PLANTE, Chloé ROBIC, Lisa ROSSIG. Our sincere thanks to them for their contribution to our work and, indirectly, to the production of this guide.

Thanks also to Bruno CARREZ for his constant support.

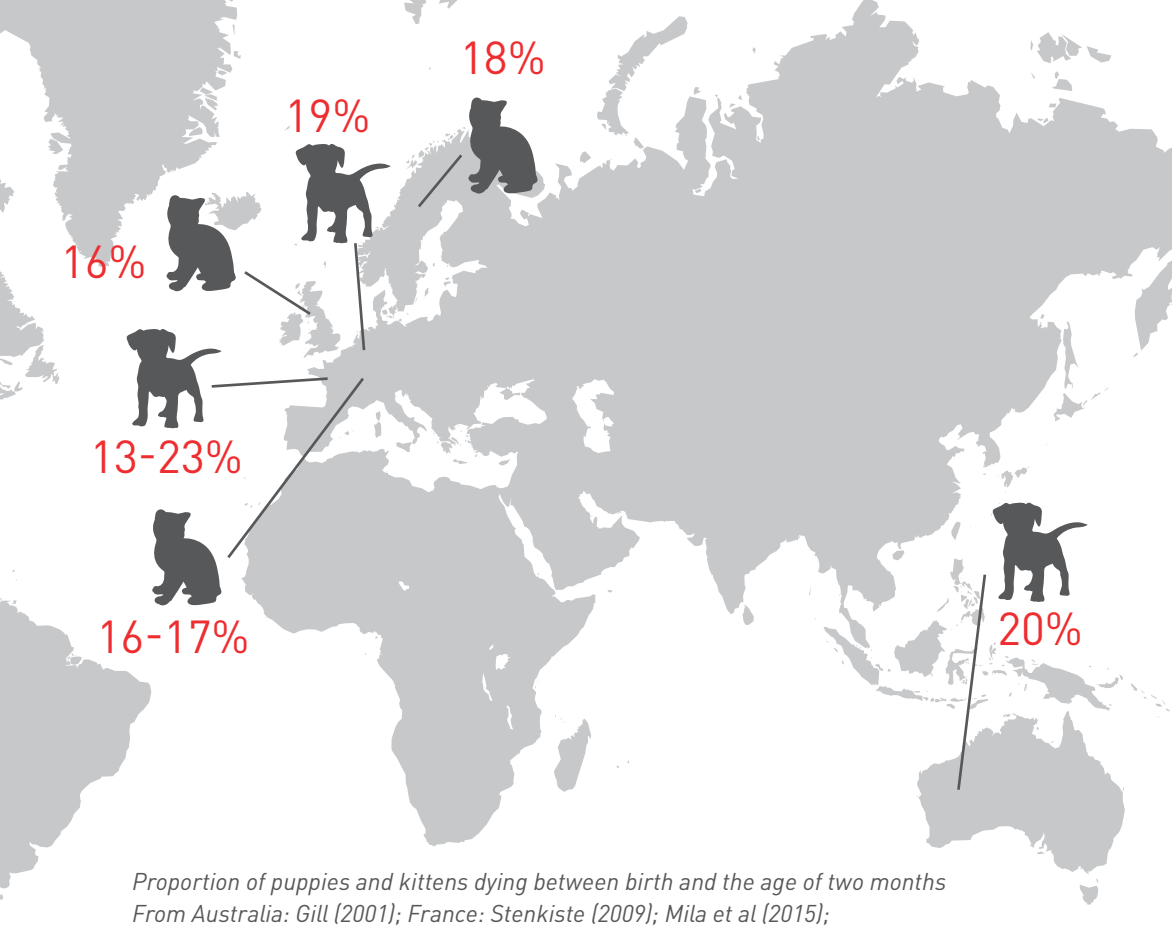
Editorial coordination : *Laureline Malineau.*

1 INTRODUCTION



1. INTRODUCTION

The perinatal period is crucial for all newborn mammals. They must adapt to the radical change of leaving intra-uterine life for the world outside. During gestation, the foetus is provided with oxygen and nutrients via the placenta, and the uterus is an environment in which temperature remains constant. After birth, the foetus is separated from the placenta and leaves the uterus: going from foetal life, to life outside the uterus requires the newborn to breathe and find its food, while subjecting it to varying temperatures. Unlike foals or calves, puppies and kittens are totally dependent upon their mothers when they are first born, being largely immature (they are **nidicolous animals**). The weight of a puppy or kitten at birth is around 1 to 3% of the maternal weight, which is equivalent to the weight of a premature child (between 600g and 2kg). **Puppies and kittens are therefore highly sensitive during the first three weeks of their lives**.

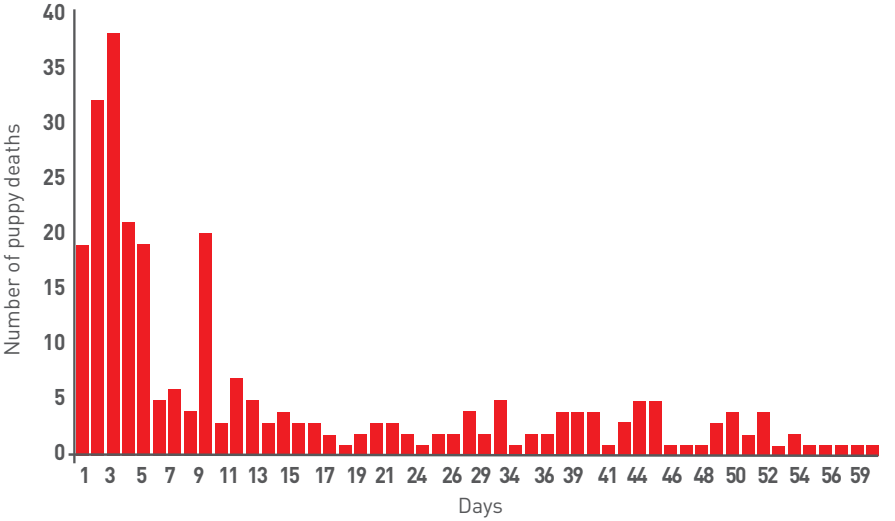


Proportion of puppies and kittens dying between birth and the age of two months
From Australia: Gill (2001); France: Stenkiste (2009); Mila et al (2015); Chastant-Maillard et al (2016); Fournier et al (2016); Netherlands: Nielen et al 1998; USA: Smith et al (1968); Poktay et al (1977); UK: Sparkes et al (2006).

This immaturity, which implies that major efforts are required to adapt to extra-uterine life, may explain the high level of neonatal mortality observed in dogs and cats. **Today, approximately 20% of puppies and kittens die before they are two months old.** Almost all studies, carried out in vastly different countries around the world and including a very large number of puppies and kittens, converge towards this high percentage.

This mortality mainly occurs during the first few days of life. A Norwegian study of pedigree cats reported that 85% of total neonatal mortality occurred between birth and the age of 7 days. Similarly, in puppies, 50-90% of neonatal mortality occurs during the first week of life.

Age at death (295 puppies of various breeds). Belin, 2013



On average, 20% of puppies die before the age of 2 months.

However, **this high mortality rate is not inevitable.** Simple measures can be taken in the breeding facility to help keep it down. This guide aims to provide practical advice on taking care of these particularly sensitive newborn puppies and kittens.

The different ways of measuring mortality in puppies and kittens

When comparing mortality figures in puppies and kittens in different breeding facilities or in different studies, it is important to specify the period considered for the calculation. Depending on the period, the rate of morality can vary by as much as 100%.

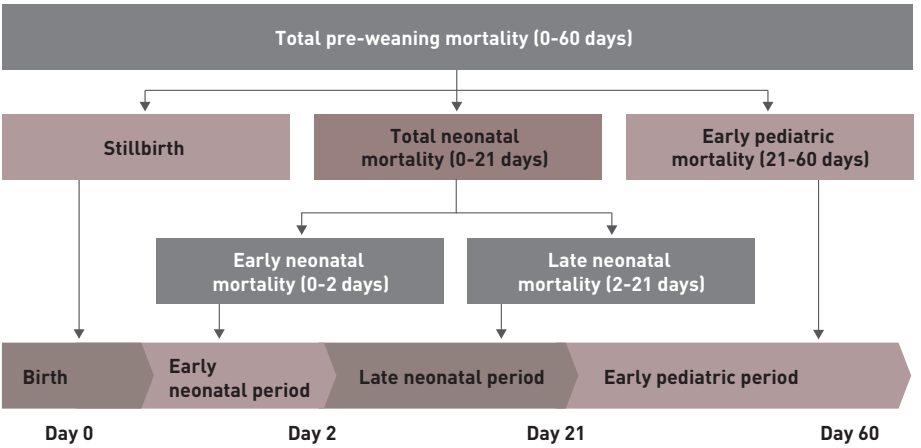
Mortinatality refers to puppies and kittens born dead. This rate is therefore calculated by the ratio of stillborn puppies and kittens to the total number of puppies and kittens born.

Neonatal mortality refers to puppies and kittens born alive but dying before the age of 21 days. This rate is calculated as the number of puppies and kittens born alive but dying before the age of 21 days, divided by the total number of puppies and kittens born alive. This rate is also sometimes calculated by dividing by the total number of puppies born, but in this case it is artificially reduced. Distinction can then be made between early neonatal mortality (death of puppies and kittens born alive and dying before the age of 2 days) and late neonatal mortality (death occurring between the ages of 2 and 21 days); these types of mortality do not have the same causes or risk factors.

Early paediatric mortality refers to puppies dying between the ages of 21 and 60 days. The rate is calculated by dividing the number of puppies/kittens dying between the ages of 21 and 60 days, by the number of puppies/kittens alive at the age of 21 days. It is sometimes also calculated by comparing this figure with either the total number of puppies/kittens born, or with the number of puppies/kittens born alive, but in this case, it is artificially reduced.

Total pre-weaning mortality refers to the puppies or kittens dying within the first 60 days of life. This rate is calculated by dividing the number of puppies or kittens dying since birth (stillborn + dying between birth and 60 days old), by the total number of puppies/kittens born (born alive + stillborn).

Definitions and calculations of mortality in puppies and kittens before weaning



Stillbirth = Total of stillborn puppies / Total number of puppies born (stillborn + born alive)

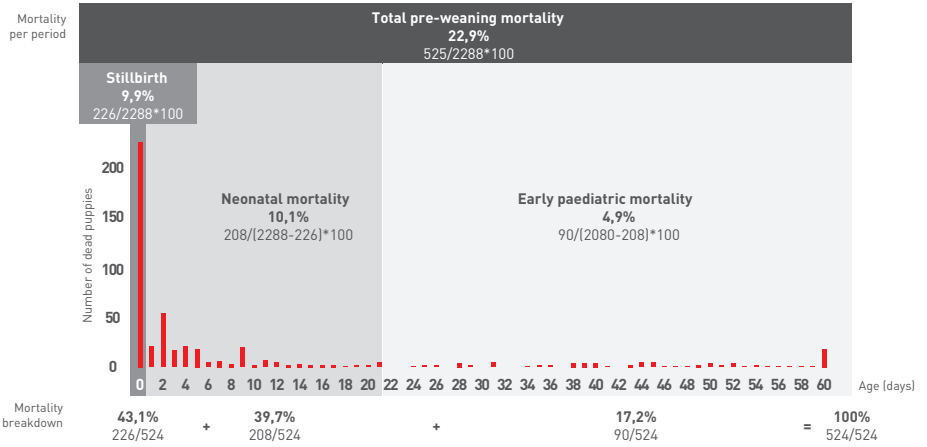
Early neonatal mortality = Total number of puppies dying between birth and 2 days of age / Total number of puppies born alive

Late neonatal mortality = Total number of puppies dying between 2 and 21 days of age / Total number of puppies alive at 2 days of age

Early pediatric mortality = Total number of puppies dying between 21 and 60 days of life / Total number of puppies alive at 21 days of age

Total pre-weaning mortality = Total number of puppies dying between birth and 60 days (stillborn + dying during the 60 first days) / Total number of puppies born (stillborn + born alive)

Example: calculation of neonatal mortality rates in a breeding facility. NeoCare, ENVT. During the study period, 2,288 puppies were born. 524 of them died before the age of 60 days.



- **The causes of neonatal mortality are multiple.** In addition, the death of a newborn is often due to a combination of several causes. This is described as **multifactorial mortality.**

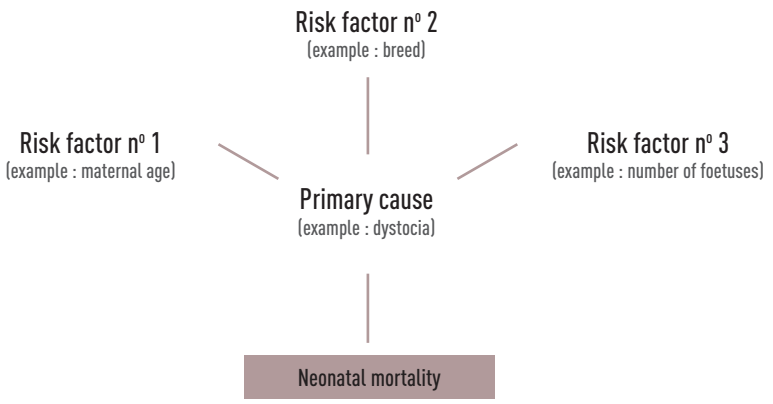
- Among the causes of mortality, distinction must be made between **primary causes** and **risk factors.** Some causes, the primary causes, have a direct influence on neonatal health, and particularly neonatal mortality. For example, dystocia (difficult birth) is a primary cause of mortality: some puppies and kittens lack oxygen (hypoxia) during the birthing process and will therefore die. Other factors have an indirect effect on the health of newborns, modulating the risk of appearance of a primary cause: these are risk factors. The age of the mother is one example of a risk factor of neonatal mortality: older dogs run a higher risk of dystocia (primary factor), the age of the dog (risk factor) therefore indirectly increases neonatal mortality.

- The causes of mortality must be sought not only **after the birth,** but also before, **during the heat period and gestation.** Some factors related to the mother influence neonatal health.

- **Four different periods** should be considered to improve neonatal health:
  - gestation,
  - birth,
  - the first 48 hours of life
  - the period 2-21 days old.

This guide will therefore consider each of the four periods, discussing the primary causes affecting neonatal health, the risk factors and how to optimise health.

Primary causes and risk factors of neonatal mortality



2 GESTATION AND NEONATAL HEALTH

Neonatal health

Mating | Gestation | Birth | 0-2 days of life | 2-21 days of life

2.1. BIRTH WEIGHT: A REFLECTION OF FOETAL DEVELOPMENT

2.1.1. BIRTH WEIGHT INFLUENCES THE CHANCES OF SURVIVAL

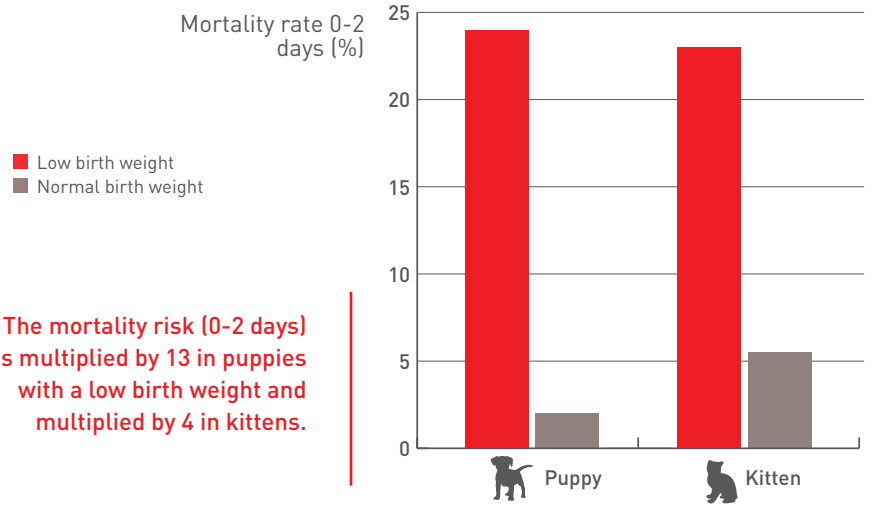
The birth weight, reflective of intra-uterine growth, is an indicator of the relative maturity of the puppies and kittens (1-3% of the mother's weight, depending on breed size).

Low birth weight is a major risk factor of neonatal mortality

At birth, puppies weigh around 1-3% of the expected adult weight for their breed and kittens are born at around 2-3% of their mother's weight. In this respect, they are very similar to premature babies, born at 1 kg instead of 3 or 4 kg.

Puppies or kittens with a low birth weight have a higher metabolism, lower reserves of hepatic glycogen and a higher body surface area / body weight ratio than heavier newborns. The energy requirements of these low birth weight animals are therefore higher to maintain their blood glucose level and body temperature; they are at greater risk of hypoglycaemia and hypothermia. Their vitality at birth (APGAR score, see below) is also lower. All these parameters expose newborns to a higher risk of neonatal mortality. In both puppies and kittens, it is currently considered that birth weight is low if it is within the bottom 25% for a given breed. **Low birth weight is a major risk factor** as shown by a study carried out on 514 puppies, which reported that 81% of the puppies that died within the first 48 hours of life had a "low" birth weight according to this definition.

Importance of birth weight in the survival prognosis of puppies and kittens between 0 and 2 days. Birth weight is considered low if it is within the bottom 25% for the breed.



The mortality risk (0-2 days) is multiplied by 13 in puppies with a low birth weight and multiplied by 4 in kittens.

It is important to weigh puppies and kittens at birth to identify those with a low birth weight. These animals must be monitored with particular attention during the first week of life (weekly weigh-in).

2.1.2. WHY DO SOME NEWBORNS HAVE A LOW WEIGHT AT BIRTH?

A number of factors influence birth weight. In dogs and cats, the two main decisive factors are the **size of the breed** concerned and the **size of the litter**. Large breed dogs have puppies with a higher birth weight than small breed dogs. Research is underway to determine the pathological thresholds for each breed in both dogs and cats.

Furthermore, puppies from large litters have a much lower birth weight than those from smaller litters. The number of puppies defining a "small" or "large" litter varies depending on the size of the breed.

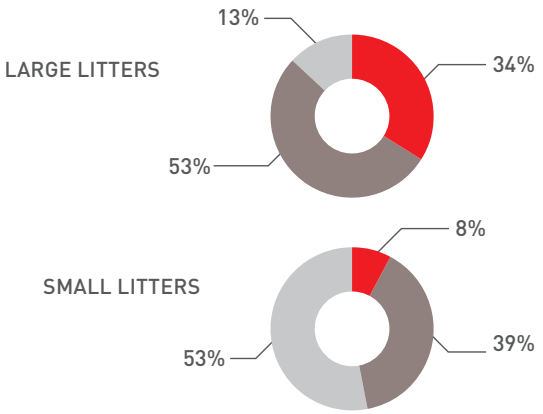
Litter size depending on breed size

Breed size	Litter size (number of puppies per litter)		
	Small	Medium	Large
Mini	< 4	4-5	> 5
Medium	< 5	5-6	> 6
Maxi	< 6	6-9	> 9

Definition of low birth weight
Below these limits, the risk of neonatal mortality increases.

Breed	Low birth weight
Lhasa Apso (50 puppies)	< 180 g
Cocker Spaniel (90 puppies)	< 225 g
Golden Retriever (104 puppies)	< 330 g
British Shorthair (71 kittens)	< 90 g
Maine coon (40 kittens)	< 115 g

Influence of litter size on birth weight (n=514 puppies)



The risk of a puppy being born with a low weight is multiplied by four if it is from a large litter

Proportion of puppies with :

- **Low birth weight**
- **Medium birth weight**
- **High birth weight**

How to weigh a newborn

The scales must be suitable for the expected weight range (which depends on the breed). The measurable weight range must not be increased to the detriment of measurement accuracy for lower values. Measurement accuracy is very important during the first few days, becoming less so as the animals grow (and get older). Accuracy is indicated in the technical specifications of all scales and should be around one gram. Ideally, the accuracy of the measured values should be checked regularly, using old Roberval scale weights or food products whose weight is known (e.g. 1kg sugar poured into a plastic bag). A high-sided basin prevents the animal from falling. It should be perfectly clean and disinfected, particularly when weighing newborns.

The weighing platform or basin should be disinfected between two litters at the least to limit the risk of contagion (mainly for weighing older puppies and kittens, more than three weeks old, because of the risk of transmission of canine and feline parvovirus (puppies / kittens), calicivirus (kittens), ringworm (kittens), etc.).

Newborns must be weighed using precision scales to identify individual puppies/kittens with a low birth weight.

2.2. OPTIMISATION OF FOETAL DEVELOPMENT

2.2.1. CONCEPT OF OPTIMAL FOETAL DEVELOPMENT

Birth weight is undeniably useful in identifying animals with a high risk of neonatal mortality. However, it does not take into account every aspect of foetal growth and development and ignores other elements, which can affect the state of health during the first few weeks of life. For example, birth weight is not a good indicator of cognitive development. Several factors during gestation can damage or improve the cerebral development of the foetus, and yet have no influence on its birth weight. This is true of DHA (docosahexaenoic acid, an omega-3 fatty acid). DHA is a major component of the brain, the organ with the highest lipid content in mammals, after the adipose tissue. Approximately one third of the lipid structure of the brain is made up of omega-3 fatty acids (almost exclusively DHA). **Giving females DHA during the gestation period thus improves the neurological and behavioural development of newborns.** DHA influences the health of a newborn without necessarily acting on its birth weight. This is why a broader strategy must be considered for puppies and kittens: optimisation of foetal development, of which birth weight is just one element. ▶

The notion of optimal foetal development goes beyond the concept of survival during the first few days of life. Recent research shows that sub-optimal development of the foetus can have consequences throughout its life, as an adult and even on the next generations (this is known as "foetal programming").

Optimal foetal development can be defined as *"that state at birth in which the neonate is most likely to survive and thrive through the neonatal transition and infancy, and to be prepared such that early developmental effects do not impact negatively on the individual's life-course"* (according to the World Health Organisation).

This notion of optimal foetal development thus encompasses a vast set of parameters, including:

- health of the mother before and after gestation,
- genetics,
- birth weight of the newborn,
- possible foetal development anomalies.

2.2.2. HOW TO OPTIMISE FOETAL DEVELOPMENT?

To optimise foetal development and therefore the health of future puppies and kittens, action is possible on a range of parameters, such as the **choice of reproducers** (particularly in terms of consanguinity), **animal nutrition, medical prophylaxis** (vaccination and de-worming), and the **environment** (maternity). Below, we have listed a few key points to enable the optimisation of foetal development.

2.2.2.1 EVALUATION OF BODY CONDITION SCORE BEFORE AND DURING GESTATION

In women, excess weight and obesity in the mother are associated with reduced fertility, an increased risk of spontaneous abortion (miscarriage), a higher rate of congenital malformation and an increased risk of in-utero foetal death and early neonatal death. Several factors may explain the influence of obesity on these parameters, such as hormonal deregulation (secretion by the fatty cells of oestrogen and a specific hormone - leptin – which affects the secretion of reproductive hormones) or a chronic inflammatory state that alters the uterine environment. Obesity induces a generalised state of inflammation.

Overweight and obese dogs and cats also secrete high levels of leptin, resulting in a risk of reduced fertility and prolificacy, as in humans. Going further, recent research in dogs demonstrated the effect of excess weight and obesity on neonatal mortality. **Puppies of mothers who are overweight or obese at the time of mating have a four times higher risk of neonatal mortality** than puppies of mothers with an ideal body condition score.

In order to limit the risks of neonatal mortality, **it is therefore recommended not to mate overweight or obese dogs or cats.** Evaluation scales are now available, enabling breeders to assess the body condition score of their animals. **It is also important to control the animal's weight gain during gestation and to avoid excessive food intake.**

Evaluation scale for body condition score in cats

TOO THIN

1

- Ribs, spine and pelvic bones easily visible on shorthaired cats
- Very narrow waist
- Small amount of muscle
- No palpable fat on the rib cage
- Severe abdominal tuck

2

- Ribs easily visible on shorthaired cats
- Very narrow waist
- Loss of muscle mass
- No palpable fat on the rib cage
- Very pronounced abdominal tuck

IDEAL

3

- Ribs visible on shorthaired cats
- Obvious waist
- Very small amount of abdominal fat
- Marked abdominal tuck

4

- Ribs not visible but are easily palpable
- Obvious waist
- Minimal amount of abdominal fat

5

- Well proportioned
- Ribs not visible but are easily palpable
- Obvious waist
- Small amount of abdominal fat
- Slight abdominal tuck

OVERWEIGHT

6

- Ribs not visible but palpable
- Waist not clearly defined when seen from above
- Very slight abdominal tuck

TOO HEAVY

7

- Ribs difficult to palpate under the fat
- Waist barely visible
- No abdominal tuck
- Rounding of abdomen with moderate abdominal pad

8

- Ribs not palpable under the fat
- Waist not visible
- Slight abdominal distension

9

- Ribs not palpable under a thick layer of fat
- Waist absent
- Obvious abdominal distension
- Extensive abdominal fat deposits

Evaluation scale for body condition score in dogs

TOO THIN

1

- Ribs, lumbar vertebrae, pelvic bones and all bony prominences evident from a distance
- No discernible body fat
- Obvious loss of muscle mass

2

- Ribs, lumbar vertebrae, and pelvic bones easily visible
- No palpable fat
- Some bony prominences visible from a distance
- Minimal loss of muscle mass

IDEAL

3

- Ribs easily palpable and may be visible with no palpable fat
- Tops of lumber vertebrae visible, pelvic bones becoming prominent
- Obvious waist and abdominal tuck

4

- Ribs easily palpable with minimal fat covering
- Waist easily noted when viewed from above
- Abdominal tuck evident

OVERWEIGHT

5

- Ribs palpable without excess fat covering
- Waist observed behind ribs when viewed from above
- Abdomen tucked up when viewed from side

6

- Ribs palpable with slight excess of fat covering
- Waist is discernible when viewed from above but is not prominent
- Abdominal tuck apparent

TOO HEAVY

7

- Ribs palpable with difficulty, heavy fat cover
- Noticeable fat deposits over lumbar area and base of tail
- Waist absent or barely visible
- Abdominal tuck may be absent

8

- Ribs not palpable under very heavy fat cover or palpable only with significant pressure
- Heavy fat deposits over lumbar area and base of tail
- Waist absent
- No abdominal tuck
- Obvious abdominal distension may be present

9

- Massive fat deposits over thorax, spine, and base of tail
- Waist and abdominal tuck absent
- Fat deposits on neck and limbs
- Obvious abdominal distension

How to assess body condition by palpation

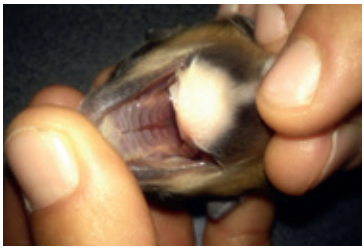
1. Palpation of the ribs: Place the hands flat on each side of the cat's thorax and move them back and forwards. This is used at access the kindness of the adipose layer over the ribs. For an optimal body condition score, you should be able to count the ribs with the finger-tips without having to apply pressure.

2. Palpation of the spinous processes, lumbar muscles, and the points of ilium: Move a hand over the spine, palpate the lumbar muscle masses and the bones of the pelvis. For an optimal body condition score you should be able to feel all of the boney prominences, and feel sufficient muscle mass (black flat and muscular).

3. Palpation of the ventral touch: Pass a hand under the cat's belly (if possible !) and palpate the inguinal fat pouch. For a normal body condition score, this fat pouch may be présent but should be small.

2.2.2.2 FOLIC ACID SUPPLEMENTS AND PREVENTION OF CLEFT PALATE

Cleft palate is an opening in the roof of the mouth, resulting in communication between the buccal cavity and the nasal cavity. This congenital malformation, i.e. present at birth, occurs in domestic carnivores as well as in humans.



The World Health Organisation (WHO) **currently recommends daily folic acid supplements for women trying to get pregnant** in order to prevent cleft palate in the baby (5mg/day for women at risk and 0.4mg/day for women with no particular risk).

In dogs, cleft palate affects many breeds, including the Boxer, French Bulldog, English Bulldog, Cavalier King Charles Spaniel, West Highland White Terrier, Collie, German Shepherd and Chihuahua. Brachycephalic breeds seem to be most affected.

Based on practices in human medicine, a study has tested the effects of folic acid supplements (5mg folic acid/day/dog) on the frequency of appearance of cleft palate in puppies. **This study reports a 76% reduction in the frequency of cleft palate in puppies born to mothers receiving folic acid supplements during gestation.** Today, industrial food rich in folic acid can be given to expectant mothers from the start of their gestation to limit the risk of cleft palate. Because of the genetic component of this anomaly, some cases may occur in spite of folic acid supplements, which is another reason for choosing breeding stock carefully.

2.2.2.3 VACCINATION STATUS BEFORE STARTING REPRODUCTION

During the first few weeks of life, puppies and kittens are protected from infectious diseases by maternal antibodies passed on during the first few hours of life in the colostrum (see below). The immune quality of colostrum is therefore extremely important to the protection of newborns during their first few weeks. This optimal quality can only be achieved if the mother is properly vaccinated before being mated.

Consultation with your vet is therefore recommended to assess (and correct if necessary) **the vaccination status of your animal before mating.** In addition, certain vaccinations may be proposed specifically during the period of heat if required by the sanitary situation, notably as protection against CHV.

2.2.2.4 DE-WORMING DURING GESTATION

It may be advisable to **de-worm the animals before mating.**

The de-worming protocol should be adapted, not only to the geographic region of the breeding site, but also to the parasitic agents present in the facility.

A series of annual group coproscopies enables evaluation of the parasites present in the breeding facility: this involves collecting stools from 3 to 5 individuals and mixing them to perform a single microscopic analysis, thereby reducing costs.
If several litters of puppies/kittens of different ages are present at the same time, two separate group coproscopies can be carried out on the stools from the puppies/kittens:
a first one on the puppies/kittens between 4 and 6 weeks old and second one on the puppies/kittens between 6 and 9 weeks old.
Samples are taken from three animal populations:
- dogs/cats in anoestrus and studs
- gestating and feeding dogs/cats
- puppies/kittens during periweaning (between 4 and 8 weeks old).

Your vet will be able to implement targeted anti-parasite treatment according to the results obtained.

The choice of molecules will be based on the spectrum of action, treatment duration, frequency of administration, ease of administration and cost. In view of the high prevalence of toxocariasis in dogs (Toxocara canis), and bearing in mind that this parasite can migrate from mother to foetus (transplacental passage), **systematic de-worming of gestating mothers with a molecule targeting this parasite is recommended around 42 days into gestation.**

The puppies/kittens can be de-wormed every two weeks, from the age of two weeks to six months old. The mother must be de-wormed at the same time as her puppies/kittens.

3 BIRTH AND NEONATAL HEALTH

Neonatal health				
Mating	Gestation	Birth	0-2 days of life	2-21 days of life

The risks related to birth for the newborn are two-fold: they may suffer a lack of oxygen for varying durations due to abruption of the placenta (hypoxia) and they come into immediate contact with surrounding bacteria and viruses having left the ultra-sterile environment of the uterus. **The design of the maternity unit, the hygiene measures implemented and monitoring of the birth can help to limit the consequences on neonatal health.**

3.1. OPTIMISING THE MATERNITY UNIT

In a breeding facility, expectant dogs and cats must be isolated in a quiet area, protected from microbes and with restricted access: this is the maternity unit.

Ideally, they should have time to get accustomed to the new place, which is why it is recommended to **transfer them one to two weeks before the expected delivery date.** This area must be **separate from the sectors for adult animals.** In a large breeding facility, it should be placed upward of prevailing winds to prevent the introduction of microbes from other sectors. In smaller facilities, it is **recommended that dogs and cats about to give birth be isolated in a room designed for this purpose,** and kept inaccessible to other adult animals, even when the room is not in use.

Before entering the maternity unit the future mother should be washed or brushed to remove as many microbes and parasites as possible.
To avoid insects, and particularly lice in summer, it is wise to place an insecticide block in the maternity unit and, in hot regions, fly curtains in the doorways and nets on the windows to prevent entry by flying insects.

The maternity unit, and particularly the nest, should be heated. During the first week, while the mother is present, it should be kept at 24°C at least for the newborns, since they require specific protection from the cold. One of the best techniques is to use thermostat-controlled heated mats. However, these are expensive. Hot water bottles should not be used because they are too hot at first and may burn the newborns, then cool quickly, ceasing to fulfil their purpose. Radiators can dry out the ambient air and tend to direct the heat upwards rather than into the birthing nest. The most commonly used heat sources in the maternity sectors of breeding facilities are radiation lamps, which project heat downwards, or height-adjustable infrared lamps, like those used for chick incubators, which enable temperature to be maintained precisely and constantly in the nest. In newly designed facilities, maternity units may sometimes have underfloor heating. ▶

It should be remembered that heat rises, which means that the temperature in the maternity unit should be checked by a thermometer in the nest and not on the walls.

In some cases of viral disease (e.g. herpes virus), the birthing nest must be heated to a higher temperature, around 30°C, to inactivate the virus. The mothers, whether dogs or cats, find these high temperatures hard to bear. They **must be allowed to distance themselves from the heat source from time to time to cool down.** This means having **a maternity sector that is large enough for them** to leave the whelping box and go and get some fresh air if they want to. Some mothers, if obliged to remain in the full heat all the time, may become less patient with their offspring, take less care of them and produce less milk. In France, for example, the law states that a maternity unit of at least 5m² should be provided for dogs and 2m² for cats.

Some breeders manage to acquire old, remodelled paediatric incubators from human maternity units. This is a good means of having a heated nest in which to install weak or hypoxic newborns, to warm them up in optimal environmental and safety conditions.

Hygrometry in the maternity sector must also be controlled. Newborns have thin skin with little keratin and a very high body surface area compared with their weight, meaning they can dehydrate very quickly. **A rate of humidity of between 65% and 70% is ideal.** It should be checked regularly with a hygrometer, a mandatory measure in some countries. **If humidity is too low, the young may become dehydrated,** while **excessive humidity encourages the development of microbes and illnesses.** If the atmosphere in the maternity unit becomes stuffy, like in a tropical country, humidity is too high. Water droplets due to condensation of the ambient water can be observed on walls and windows: this must be avoided. **It is therefore not recommended to have dogs or cats deliver in a bathroom,** which is too damp and too busy (unless of course, it is not used by anyone). If necessary, humidifiers (or just basins of water) or dehumidifiers, depending on the case, can be placed in the maternity unit.

Finally, it is important to **check that the maternity area is adequately aired.** This can be tested with a simple candle: bring a flame (candle or lighter) close to the birthing nest; the flame should flicker slightly but not be blown down or out by a strong draught, which could be detrimental to the health of the newborns.

THE WHELPING BOX

For small breed dogs and cats, a simple basket can be prepared to make an ideal nest. If the dog weighs more than 15-20kg, it is wise to put her in a whelping box, which will prevent the future puppies from leaving the nest and, more importantly, prevent the mother from crushing them when she lies down. The idea of this system is to provide a safe area for the puppies, thanks to metal or wooden rods (like simple broom handles) placed 10-15cm from the floor and equally distant from the sides of the box. If the mother lies down too close to the edge, the puppies will roll under the bars, protecting them from getting stuck or smothered. This type of accident is common with an unprotected nest.
The whelping box should be built from an easily washed, disinfectable and non-porous material. Untreated wood, for example, should not be used. Ideally, the base of the whelping box should be covered with newspaper – an excellent thermal insulator – clean towels or sheets, the important thing being that the covering can be changed easily if it becomes damp or soiled. Absorbent paper, wood shavings and cushions, which store humidity and encourage the development of microbes, are not recommended.

HEAT CYCLE OF LACTATING CATS

15-20% of cats that have just had kittens come on heat within days of delivery, even while nursing their young. Some cats may abandon their kittens to seek a partner. It is therefore important that the room should remain properly closed, thus avoiding such problems.

3.2. OPTIMISING HYGIENE IN THE MATERNITY UNIT

It is **essential that this sector, which is home to the most fragile animals in the facility, be kept perfectly hygienic.** First, **the number of people with access to this sector should be limited.** Entry should be restricted to those with a specific role. There is no question of visitors, friends and children going in and out. In order to limit stress and to ensure that the place remains calm, as far as possible, birthing and lactating mothers should not be disturbed. When designing the maternity unit, glazed partitions are useful to enable observation of the mothers without necessarily having to get close to them. Webcam type cameras can also be installed to enable monitoring from afar. ▶

To **limit microbial risks,** there are a number of rules to be implemented. The **"forward flow"** principle is a hygiene rule for breeding facilities that consists of systematically starting in the highest risk area, in this case, the maternity unit, for all daily activities (cleaning, changing litter, providing food and water, etc.), to be sure not to introduce infectious agents from other parts of the facility. However, this is not sufficient.

> At the very least, it is recommended to take particular care over the microbial risks represented by **hands and shoes** when entering the maternity sector.

Hand washing with soap and water or rubbing with hydro-alcoholic gel is recommended, while for the feet, there are several possible solutions.

Footbaths at the entrance may be effective, provided they are changed regularly, which is not always the case in breeding facilities, meaning that they may actually represent a danger by suggesting that access to the maternity unit is safe, when in fact it is not. Such systems are not suitable for small, family breeding operations. A much better solution is to remove shoes before going in and to put on specific shoes (such as "Crocs™") reserved for use in this sector.

Disposable plastic overshoes can also be used to cover your normal shoes. In large facilities, it is essential that measures are not limited to just hands and feet, but extended to include putting on a specific apron or overall reserved for use in the maternity.

Similarly, the cleaning equipment must be specifically reserved for use in the maternity unit. Brooms, buckets, spades, mops and sponges must remain in the maternity unit and not be used in other sectors of the facility.

It may help to choose equipment of a certain colour to be used in this sector. Be extra careful with litter trays, which must be used only in the maternity unit. Use of vacuum cleaners, which often carry microbes in their bags, also requires caution: use in the maternity sector first, with a new bag each time.

Other precautions are also desirable. Lactating dogs must be allowed out in a **recreation area separate** from that used by the other dogs in the facility. There is still some debate as to whether weaned puppies and kittens should be transferred to another sector (often referred to as a **nursery**) or if they can be left in the maternity unit. Without giving a final answer, it should be remembered that after weaning, young pups and kittens are no longer washed by their mother and are very lively (playing, exploring the area, etc.). They thus generate dirt, which is not recommended for a maternity unit, in which hygiene must be meticulously controlled.

If space and layout allows, a nursery separate from the maternity is probably a good idea.

It is important that the maternity sector does not house too many litters at once, since this increases the microbial load and the risk of disease development. In a large breeding facility, it is best to have several small maternity units, kept separate from one another with their own access security and specific equipment, rather than one larger maternity area.

Wherever possible, it is recommended that the maternity equipment (whelping box, radiators, etc.) be fully dismountable and disinfectable. This enables the sector to be totally emptied once or twice a year to enable cleaning, disinfection and elimination of all insects. The sector is then left for a week or two with no animals: a "sanitary break". This enables a significant reduction in the bacterial population of the premises.

The floor and walls of the unit must be in good condition, even and smooth, thus facilitating cleaning. Tiles are ideal for the floor and walls, provided the joints are in good condition and preferably large tiles to minimise the joints. If possible, rounded angles should be created where the floor meets the walls. Other materials can be considered, such as resin, treated concrete or even lino in a family facility, providing that such materials are in good condition, not porous and with no cracks.

Cleaning and disinfection procedures must be strict and represent no risk for the young. The **products used must be totally innocuous:** read the labels and conditions of use carefully.

Generally speaking, it is recommended that unconsumed water and food should be removed daily and the bowls washed and changed. The litter and cloth/paper used to line the nest must be changed as often as necessary.

Puppies and kittens should be placed in a separate box, cleaned and disinfected previously, while the whelping box and maternity sector are cleaned with a detergent that should be left to act for at least 10-15 minutes. Rinse then eliminate excess water with a dry cloth, scraper or water vacuum to avoid increasing the humidity rate. At a frequency depending on the size of the facility (daily, weekly), disinfectant should be applied, left to act, then rinsed thoroughly, before returning the puppies / kittens.

MORE INFORMATION:

- European Scientific Council Companion Animal Parasites (ESCCAP) website: www.esccap.org
- The Companion Animal Parasite Council (CAPC) website: www.capcvet.org
- Practical guide to dog breeding. Royal Canin, page 88
- Some common misconceptions about dog and cat breeding. Breeder Manual, Royal Canin, page 152
- Main hygiene principles for feline and canine breeders. Royal Canin.

3.3. HYPOXIA: THE PRINCIPAL RISK OF MORTALITY DURING BIRTHING

The birthing process is decisive to the health of a newborn puppy or kitten. During abnormally long or difficult births, the foetuses may lack oxygen and/or swallow abnormal amounts of amniotic fluid, thus complicating their resuscitation and exposing them to a higher risk of illness during the first few days of life. **Hypoxia is therefore the main cause of neonatal mortality in puppies (more than 60%).** The umbilical cord is relatively short in puppies and its compression may reduce umbilical circulation, particularly in puppies born via posterior presentation. Obstruction or any other form of dystocia may also lead to foetal suffering or death.

In puppies suffering serious hypoxia, and if it is impossible to implement compensatory redistribution of the blood flow, the heart rate is weaker, intestinal motility is increased and amniotic liquid is inhaled, causing damage to the intestinal mucosa and other tissues whose oxygen requirements are high (including the adrenal cortex, heart and brain). Hypoxia during birth can also cause a serious, generalised infection of the body (also called septicaemia). Puppies that survive deep hypoxia after resuscitation therefore present a high risk of dying during the first 48 hours after their birth. **Optimal management of birthing enables limitation of the risks of hypoxia and therefore improves neonatal health.** This optimal management demands good knowledge of the risk factors for dystocia, preparation of the birth and early detection of dystocia.

3.4. MONITORING THE BIRTH

3.4.1. KNOWING THE RISK FACTORS OF DYSTOCIA

Some factors which can lead to high risk birth (dystocic birth) have been studied in dogs and cats. I**t is strongly discouraged to mate a female during her first heat cycle,** because the pelvis is still too immature and the risks of the young becoming stuck is higher. Data concerning 46,000 litters indicate that mortality in puppies (at least 1 dead puppy) was observed in 36% of dogs whelping before the age of one year, compared with 26% of dogs aged between 1 and 6 years old. **It is not recommended to mate a female after the age of 6 years, or if she is obese.** In dogs, if the first gestation occurs after the age of 4, the risks of difficult birth increase. **Miniature or brachycephalic breeds** (such as English Bulldogs, French Bulldogs or Pugs) **are more prone to difficult births. Large breed dogs** (averaging over 40kg as adults) **have much more complicated births,** and are more likely to require a Caesarean section. **Small litters,** resulting in large puppies at the end of the gestation period, which will be difficult or impossible to birth due to the process not starting (the single puppy syndrome), are also at **higher risk.** Finally, **abusive use of oxytocin during birthing or excessive traction on a puppy stuck** in the pelvis considerably increases the rate of mortality in newborns.

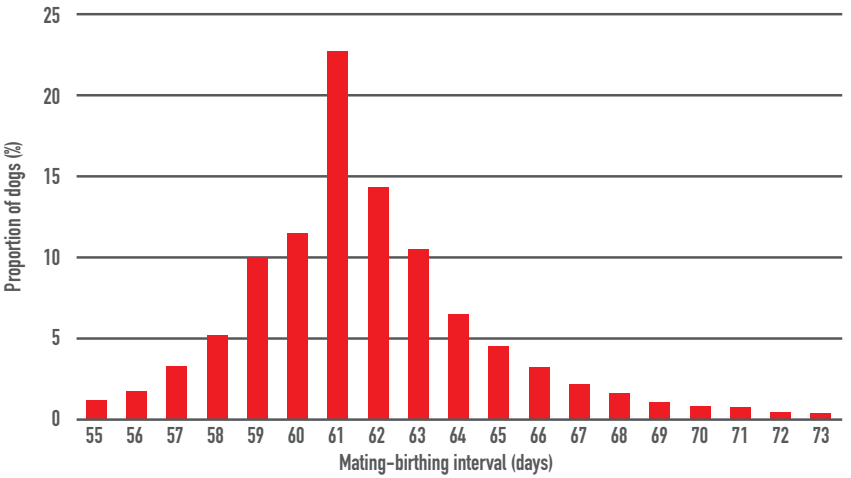
In cats, dystocic births occur in 67 out of 10,000 cases. A number of studies have shown a **predisposition in brachycephalic breeds** (Persian, British Shorthair, Devon Rex) and dolichocephalic breeds (Siamese, Oriental, Cornish Rex). **The risk factors include the number of kittens in the litter** (they are larger at birth and therefore find it more difficult to get through the birth canal) or a **small pelvis** (common in certain breeds, such as the Turkish Angora).

3.4.2. DETERMINING THE TIME OF BIRTH AND PREPARATION

It is important that the future mother, whether cat or dog, is isolated for ten days before the birth to get accustomed to the maternity unit, so that she can give birth with as little stress as possible.

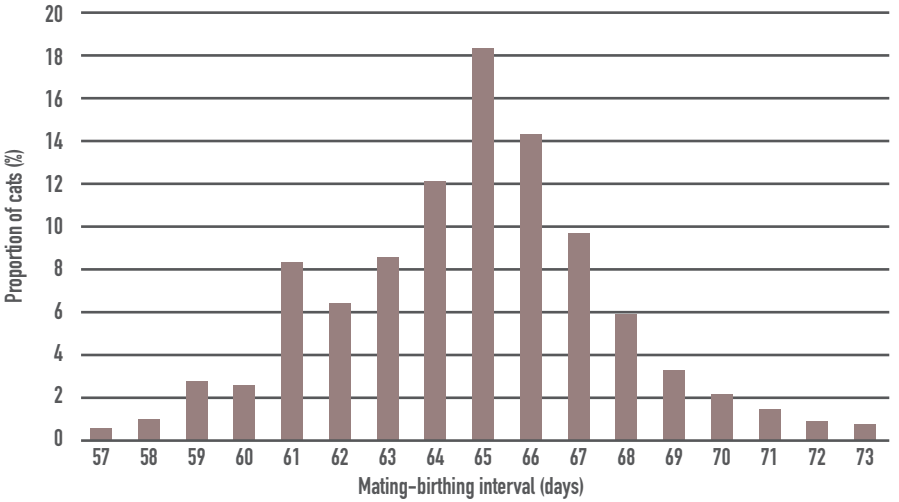
In dogs, knowing the date of ovulation makes things easier. Several studies have shown that in almost 80% of cases, the birth is **between 61 and 65 days later, with an average of 63.** In this case, all you have to do is to count the days on the calendar and set the dog up in the maternity around 10 days before the expected term. **Knowing the date of ovulation therefore enables a roughly accurate estimate of the time of birth.**

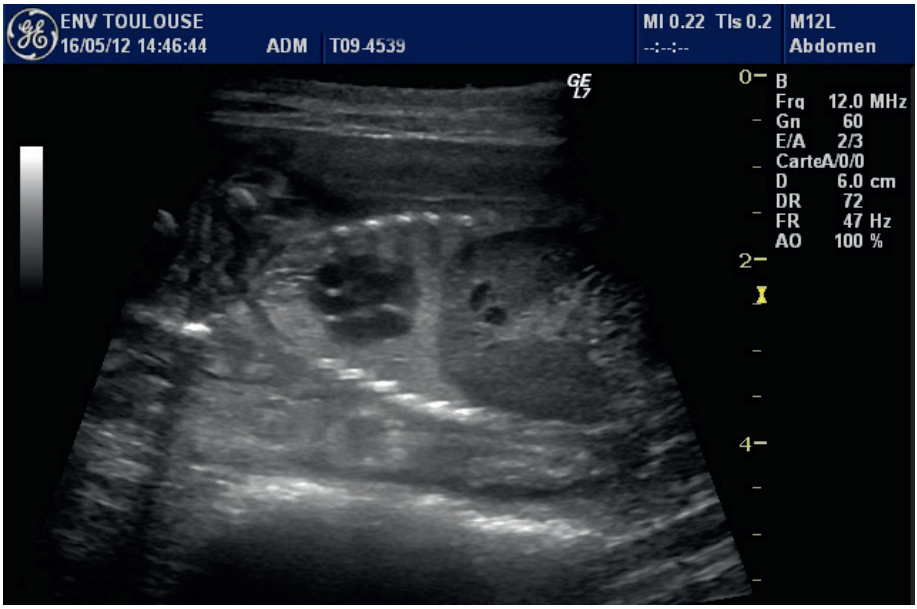
Interval between mating and birthing in 31,866 dogs



In cats, although there are some breed variations, the birth is generally approximately 65 days after successful mating.

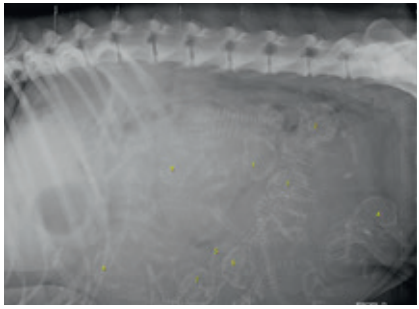
Interval between mating and birthing in 5,656 cats





An ultrasound scan during the birthing process can help to assess foetal suffering

If the time of mating and/or ovulation are not known, the vet can take a certain number of measurements on the embryonic vesicles or foetuses during the scan at different stages of the gestation to estimate the stage and the number of days remaining before birth.

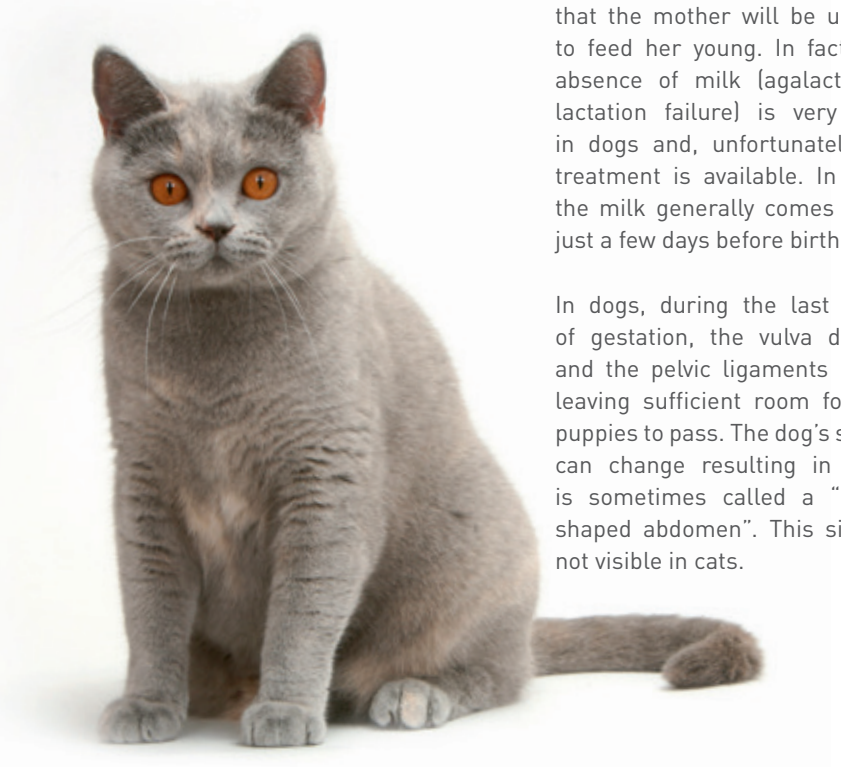


An X-ray during pregnancy can help to estimate the birth date and enables the foetuses to be counted

However, the data for large dogs, among which this estimation is more difficult, is insufficient. Towards the end of gestation, X-ray can help to date the gestation, notably by observing the degree of ossification in the foetuses.

Once the female is settled in the maternity unit *(see part 3.2: Optimising hygiene in the maternity unit*), **it helps to note the warning signs of birthing to avoid surprises.**

The appearance of milk in the mammary glands is not a reliable sign of imminent birth; in dogs, the milk generally appears 8-10 days before birth. However, this remains variable: some dogs who have already had puppies may start lactating on around the 40th day; conversely, some primipara dogs (having their first puppies) will only get their milk in the hours immediately before the birth, or even during the birthing process. This makes some breeders worry that the mother will be unable to feed her young. In fact, the absence of milk (agalactia or lactation failure) is very rare in dogs and, unfortunately, no treatment is available. In cats, the milk generally comes later, just a few days before birthing.



In dogs, during the last week of gestation, the vulva dilates and the pelvic ligaments relax, leaving sufficient room for the puppies to pass. The dog's shape can change resulting in what is sometimes called a "pear-shaped abdomen". This sign is not visible in cats.

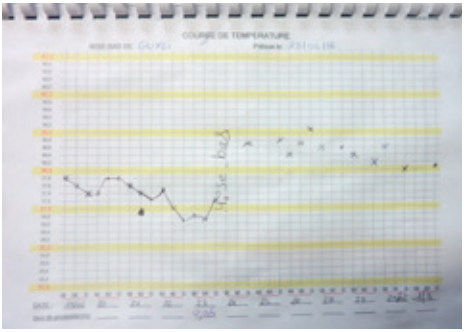
In both species, during the final hours before the birth, effacement of the cervix may result in a transparent fluid passing through the vulval opening **(cervical mucous plug).** However, this flow is not systematic. Finally, when the placentas start to detach, placental pigment is released into the uterus and becomes visible at the vulva. In dogs, this pigment (called uteroverdin) is derived from haemoglobin and is dark green, almost black, in colour. In cats, the pigment is red. **Such flows indicate that arrival of the first puppy/kitten is imminent and the mother should be monitored for the next two hours.**

Behavioural changes also occur before term. Between one and seven days before birthing, the uterus start to contract slightly. These contractions are not apparent externally, but cause alteration of the dog's attitude. During the contractions, she **will scratch the floor energetically** with her front paws, which may be disturbing, but does not mean anything is wrong. Much closer to the time, **the dog's face shows worry and she will pant.** Finally, most dogs refuse to eat during the hours before birthing, which is a good indicator of the imminent

arrival. With cats, one or two days before the birth, there is generally a sudden change in behaviour: **she will mew, become very agitated and worried.** She will **either hide or follow her master throughout the house.** This behaviour is a strong indicator.

A female about to birth undergoes a major hormonal change, essential to trigger the contractions, which would not otherwise start. In dogs, **the level of progesterone in the blood,** previously high, **drops suddenly.** Vets use this to know if the dog is at term or not: if they are, the blood progesterone level will be very low. Owners can detect this hormonal change themselves, indirectly. Progesterone has a slight hyperthermising effect on the body (tends to increase body temperature slightly). A sudden decrease 24 or 48 hours before the start of labour upsets the thermal regulation of the body and causes a sudden drop (lasting a few hours) of rectal temperature, before the temperature rises again.

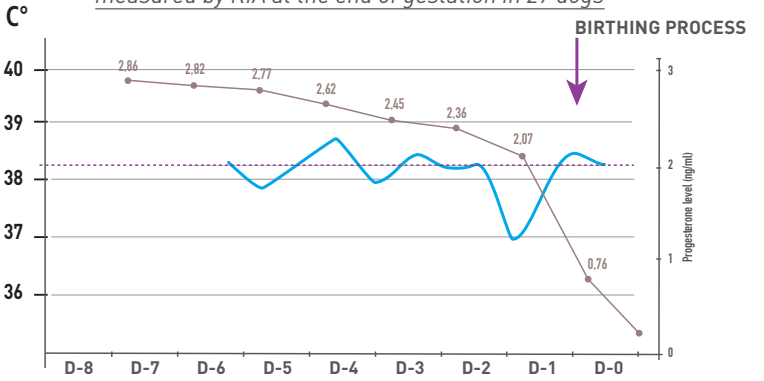
Unfortunately, this practice is much less reliable in cats, since the temperature drop before birthing is not systematic.



Body temperature can be monitored to predict birthing

Breeders are therefore accustomed to taking the temperature of expectant mothers three or four times a day during the last week of gestation. Ideally, each value should be noted: temperature falls by around one degree from the mean temperature of the previous days 24 or 48 hours before birthing. This sign is easier to see in small dogs.

Evolution of the mean rate of progesterone measured by RIA at the end of gestation in 27 dogs



Rectal temperature must be taken 3-4 times a day to detect a possible drop of approx. 1°C occurring 12-48 hours before the start of the birthing process.

3.4.3. DETECTING A DYSTOCIC BIRTH AS EARLY AS POSSIBLE

In dogs, the most common problem is the lack of uterine contractions in the mother. This is known as **uterine inertia or atony.** It may be total (no puppies are expelled) or partial (the mother delivers one or two puppies, but only after a long time and causing the foetuses to suffer, resulting in difficult births and often resuscitation problems). Some breeds (such as molossers) and lines, from mother to daughter, seem to be predisposed to this inertia. Dogs who have already suffered atony while birthing are likely to do so again. Obese and older dogs are also at higher risk. A Swedish study revealed that dogs over 7 years old are more likely to need a Caesarean section following dystocia problems.

How is dystocia detected?

Usually, the dog has contractions, but they are slight and infrequent. Sometimes, one or two puppies will be delivered with difficulty after hours of waiting, and then no more... After checking that there is no blockage, and only after checking, you can **try restarting the uterine contractions by getting the dog to walk about** – sometimes this is enough. If it is not, you can **try administering calcium,** which is fuel for the uterine muscles. For example, a tablespoonful of 10% calcium gluconate can be administered after each puppy comes out to ensure the body has enough calcium. If the contractions cease in spite of the calcium, **you can consider administering oxytocin.** In this case, **it is wise to consult your vet.** Dogs also suffer secondary fatigue of the uterus **(secondary uterine inertia).** It is not easy to distinguish between this and the previous

anomaly: for one reason or another (extra-large or badly positioned puppy, inadequate dilation of the birthing canal, etc.), **the mother cannot deliver in spite of having normal contractions.** At first, the contractions are strong and then the uterus begins to tire and the pushes become weaker. If you have not already observed the contractions, you may think you are dealing with primary atony. This type of dystocia is serious because contracting without effect causes the uterus to detach the placentas from all the foetuses and deprives them of oxygen. If obstetric or surgical measures are not taken quickly (episiotomy, Caesarean section), the newborns may well be stillborn or born very weak and impossible to revive.

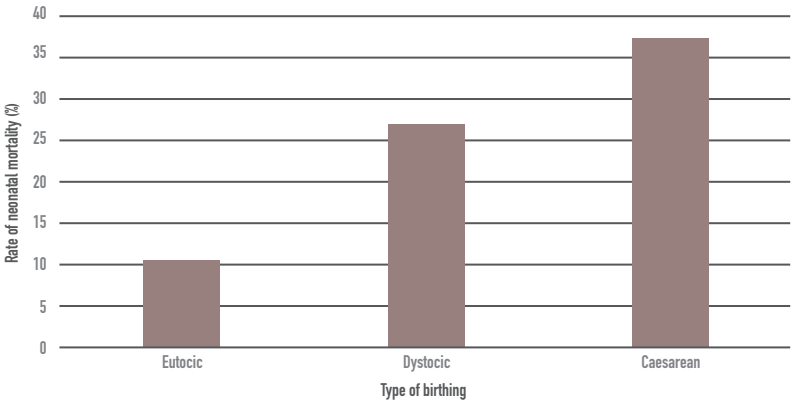
Important times

STAGE	DON'T WORRY	WORRY
Start of labour	< 24 hours after fall of rectal temperature	< 48 hours after fall of rectal temperature and no labour
Expulsion time of a puppy engaged in the pelvis	20-30 min	Duration > 45 minutes
Period between the delivery of two puppies	20-30 min 1 hour at the end of birthing	> 2 hours > 4 hours at the end of birthing
Unproductive pushing		30-60 minutes
MAJOR VARIATIONS depending on age, breed, number of puppies and number of previous litters.		

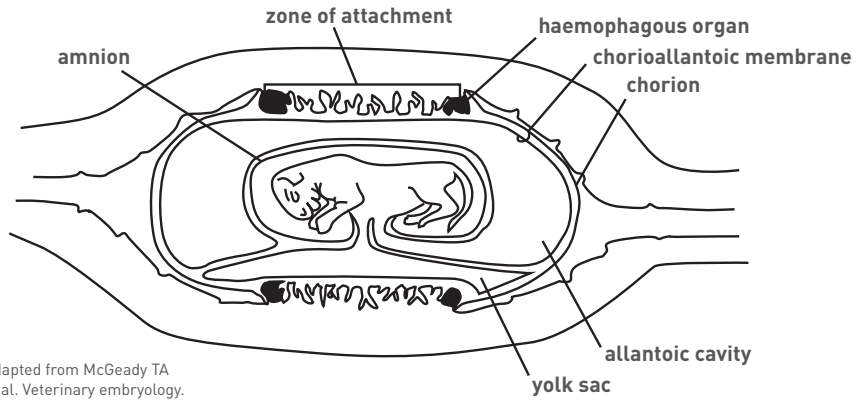
In cats, primary uterine inertia is also a major cause of dystocic birthing. If reddish vulvar discharge is observed and no kittens have arrived after 2 hours, you should be concerned. If the first kitten has still not arrived more than 4 hours after the start of the contractions, and if the mother contracts its abdomen for more than 30 minutes without a kitten being born, this is not normal. **In cats, the contracting substances of the uterus (calcium, oxytocin) are to be used with great caution (ask your vet for advice). A Caesarean section is performed in most cases of dystocic birth.**

Medical treatment is only effective in around 35% of cases of dystocic birth in cats. In all other cases, only a Caesarean section might save the newborns. However, the abnormal birth must be detected as quickly as possible; **there are far fewer stillbirths if the Caesarean section is carried out within 4-5 hours of the start of the problem.** Emergency sections often take place at night and the foetuses have already suffered. The rate of neonatal mortality is often around 25-35% in such cases, but can be up to 100%.

Rate of neonatal mortality in puppies depending on type of birthing (CERCA, ENVA data for 1,542 dogs)



Arrangement of canine foetal membranes within the uterus



Adapted from McGeady TA et al. Veterinary embryology. Blackwell Publishing. 377 pages

The vet may prefer to estimate foetal suffering before starting his/her intervention. The foetal heart rate should be around 200 beats per minute. If it falls significantly, the newborns will be more difficult to revive after the intervention.

THE EMBRYONIC ANNEXES

The placenta is an intimate connection between the two bodies and represents exchange between mother and foetus. In dogs and cats, the placenta forms a circular strip, like a ring, around the foetus (this is known as a zonary placenta). The newborn puppy or kitten is wrapped in several pouches. In simple terms, they are immersed in the amnion filled with amniotic fluid. This is the transparent pouch that surrounds the newborn at birth. This fluid protects against impacts, and has a nutritional and detoxifying role. The amnion is surrounded by another pouch, the allantoic sac, which is larger. This contains the famous "waters" that are lost between a few minutes and up to an hour before birth, when the foetus engages in the mother's pelvis.

NORMAL BIRTH IN DOGS

Birthing is a stressful time: it is important not to panic and to remember the saying that "the art of birthing is knowing how to wait".

The total duration of parturition (a scientific term for birthing) is very variable: it depends on breed, litter size, and whether or not the mother has already given birth. In general, the whole process takes between 4 and 8 hours, sometimes longer for very large litters – it is not uncommon that the dog rests for a few hours after delivering only some of the puppies – or if she is a primipara.

The average interval between two expulsions is 20 to 30 minutes. This is just an average, towards the end, it generally lasts longer. To limit the risk of problems, it is recommended to seek the advice of a vet if the period between two successive expulsions exceeds three or four hours, or if the dog has no contractions. If she is having contractions but to no avail, consult a vet immediately.

Labour starts gradually. At first, the contractions are imperceptible externally. The future mother begins to pant and starts to look worried. The waters generally break (rupture of the allantoic sac) relatively early, before expulsion of the first puppy – you may not see the liquid run out, but you can tell if the nest is wet.

In the minutes before expulsion, the dog is often very agitated. She will get up, walk around in circles, whimper. Sometimes, she may crouch, as if wanting to defecate. Strong contractions of the belly are visible lasting between 30 seconds and 1 minute, alternating with calm periods. After a slightly stronger contraction, you will first see a greenish sac at the vulva: this is the amnion, enclosing the puppy. If the sac is perforated, it does not matter. However, if the pouch is visible, but nothing has happened within an hour, consult your vet: the puppy may be too large or badly positioned or the mother's contractions may not be strong enough.

The puppy is generally pushed out by a slightly stronger contraction, usually with a single push. The amnion is usually pierced by the mother licking her pup. If not, it must be perforated, otherwise the puppy may drown. After its birth, the puppy must breathe by itself, since it is no longer getting any oxygen from the mother. The placenta is usually expelled a few minutes later.

The newborn puppy must be stretched out, i.e. with its legs stretched out forwards and backwards. In 60% of cases, it presents in the anterior position – head first – and in 40% of cases, hind quarters first (posterior presentation).

Once the puppy is well engaged in the birthing canal, it is urgent to get it out. It is usually too late to call the vet: the breeder must complete any obstetric manipulations alone. Traction must be applied with the mother standing up. If she lying down, get her to stand. The posterior part of the vagina is almost vertical, so always pull in alignment with this portion, i.e back and down, almost vertically. Never pull the puppy horizontally. With an anterior presentation, pull the head by hooking under its jaws (do not pull its legs or you may injure the shoulders). With a posterior presentation, you have no option other than pulling the legs; to do so, grasp them as high as possible, above the hocks, for example. Traction must no under any circumstances, be applied constantly to the puppy, only while the mother is pushing: this improves the effectiveness of the mother's own efforts to expel puppy.

NORMAL BIRTHING IN CATS

Birthing is generally quicker in cats, except for certain brachycephalic or giant breeds (Persians, Exotic Shorthair, Maine Coon, etc.) for which it is more complicated. In more than 80% of cats, all the kittens should be delivered within 6 hours. Unlike dogs, one in two kittens is born via posterior presentation. In some breeds (such as the Sphynx), kittens can be born with their eyes open, which never happens with dogs.

Another particularity of the cat is that she often mews very loudly throughout the birth. It can seem as if she is crying. This can be distressing for the uninitiated, but is perfectly normal. Of course, the mother must not be disturbed unnecessarily during birthing: otherwise the process could be interrupted for several hours or for even more than a day.

4 IMMEDIATE CARE OF NEWBORNS - RESUSCITATION

Neonatal health

Mating	Gestation	Birth	0-2 days of life	2-21 days of life

4.1. WHY EXAMINE A NEWBORN IMMEDIATELY AFTER ITS BIRTH?

As explained in the previous section, hypoxia is a risk factor of neonatal mortality. Hypoxia can quickly be complicated by hypothermia. Twenty-four hours after the birth, **a healthy puppy's temperature is between 35 and 36.5°C** (see below).

Newborns are not able to maintain their body temperature in a cold, damp environment. Pathological hypothermia is therefore quick to develop after the birth if the newborn remains wet, if it is in a cold place or deprived of the care normally provided by its mother. Puppies have a very low percentage of brown adipose tissue to ensure thermogenesis via shivering and vasoconstriction, but this mechanism is not fully operational at such a young age. They also have a high body mass/skin surface area ratio, which means body heat is lost quickly. **Hypothermia is particularly dangerous because it can cause other problems.** A fall in temperature can be followed by a drop in heart rate: this is the beginning of a protective response whose main goal is to avoid reducing arterial blood flow to the brain. If this situation lasts, the respiratory rate will decrease and cardio-respiratory insufficiency may develop. An abnormally low temperature in a newborn (<35 °C) may also result in the inability to suckle, the appearance of dehydration, slowing and stoppage of digestive transit. It may also increase vulnerability to infections due to the herpes virus or bacteria.

A newborn that is unable to suckle because of hypothermia will not receive the antibodies contained in the colostrum, which will further reduce its ability to fight pathogenic bacteria. These bacteria will be able to colonise the intestines of newborns, disseminating toxins or endotoxins, which can also cause death. Severe hypothermia describes the state in which body temperature falls to around 20°C: the newborn is prostrate, lying in the lateral position. In the worst cases, respiration decreases to only occasional pants. Heart rate is slowed and reflexes are extremely slow. Suckling is impossible and intestinal motility

disappears. Most animals in this situation will die. **The mothers cannot take care of newborns with a very low skin temperature and therefore leave them aside. A special thermometer enabling measurement of low temperatures is essential to detect profound hypothermia.**

Although warmth must be provided for the newborns, they must also be able to move away from the heat. Newborns may be exposed to abnormally high temperatures, such as during car transport. Transporting newborns by car in a small box surrounded by bottles of very hot water or using electric heating plates to cover the entire box may result in abnormally high temperatures. Extended exposure to such high temperatures puts the newborns in danger, because of their inability to regulate their body temperature. An overheated environment may cause panting and may lead to death due to heatstroke.

4.2. HOW TO ENSURE EFFECTIVE RESUSCITATION

Attentive monitoring of the birthing process is recommended. During a difficult birth, after a Caesarean section or if the mother fails to provide proper care to her newborns, **resuscitation may be necessary, and even crucial in certain situations,** such as a newborn being born in its sac. **These manipulations must be perfectly mastered** since the **quality of their execution can help to reduce neonatal mortality significantly.**

There are several stages to resuscitation:

• **Clear the airways**

Once rid of its sac, the newborn should be able to breathe properly. To make sure, the first thing to be done is to **free the airways of any amniotic fluid** which is often inhaled. A **suction bulb syringe can be used to suck up any fluid.** Suction must not be too aggressive to prevent causing a spasm of the larynx and reducing the heart rate. Swinging movements used to be recommended to clear the airways, but this is now counter-indicated because of the risks of brain damage that can be caused ("shaken baby syndrome").

Use of a suction bulb syringe in the mouth then nostrils of a newborn helps to clear the airways.

• **Dry and stimulate**

Having cleared the airways, the newborn should be **rubbed with clean, dry towels to stimulate it** (it is often only at this point that it will start to whimper). Do not use a hair dryer, which may dehydrate or burn the newborn.

Drying newborns with clean or disposable cloths also helps stimulate respiration.

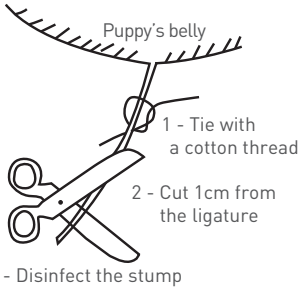
-

• **Cut and disinfect the umbilical cord**

If it has not been broken, the **umbilical cord should be immediately ligatured with a small thread or blocked by a clamp one centimetre from the belly. It is then cut, one centimetre away.** Finally, **the stump is disinfected.** When cutting and ligaturing, do not pull the cord since traction could cause a small hernia on the belly of the puppy. This is not serious, but it will persist into adulthood.

Disinfecting the umbilical cord limits the risks of infection.

Ligature



• **Warming**

Neonates should be **placed under a heat lamp or on a heated surface** (e.g. snuggle safe) during resuscitation, as chilled neonates can fail to respond to resuscitation.The temperature in contact with the newborns **should not exceed 37°C** and they **must be able to move away from the heat source.**

RECOMMENDED NEST TEMPERATURE DURING THE FIRST FEW WEEKS OF LIFE

- First week: 30°C
- Second week: 28°C
- Third week: 27°C
- Fourth week: 24-25°

Parameters to be adapted depending on the breed and ventilation in the unit

In certain critical situations, the vet may undertake more extensive resuscitation measures. This can involve oxygenating the newborns with an oxygen mask, emptying the stomach of its fluid to facilitate respiration or the use of acupuncture (Jen Chung points) to stimulate respiration.

RESUSCITATION / IMMEDIATE CARE FOR NEWBORNS

The breeder must be able to perform certain actions since the quality of their execution can help to reduce neonatal mortality significantly.

1 - Remove the neonate from its sac

2 - Free the airways
- Use a suction bulb syringe to clear the mucosa

3 - Dry and stimulate
- Rub the newborn energetically with clean, dry towels
- Do not use a hair dryer, which could dehydrate or burn the neonate

4 - Disinfect the umbilical cord
- Ligature 1cm from the belly with a small thread (if necessary)
- Cut the cord 1cm further along (2cm from the belly)
- Disinfect the stump

5 - Weigh the newborn regularly

6 - Put the newborn to the teat (stimulate the intake of colostrum)

5 CLINICAL EXAMINATION OF NEWBORNS AND DETECTION OF ANIMALS AT RISK

After resuscitating the puppy, once it is breathing properly, it must be examined more thoroughly. This examination not only enables detection of any anomalies that are visible immediately, such as congenital malformations (i.e. malformations present at birth), but also identification of the puppies at risk of neonatal mortality.

5.1. ADOPT THE RIGHT REFLEX: IDENTIFICATION OF THE NEWBORNS

First of all, the newborns must be identified so that you can recognise and monitor them individually. Monitoring their weight or APGAR score in the event of neonatal resuscitation requires prior identification, unless the coats of each individual in the litter enable certain recognition. A simple, inexpensive and safe way is to make collars from different coloured strands of wool. The collars must obviously be changed as the puppies grow. If the litter is large and you do not have enough different colours, simply combine two different colours. It is important that all the puppies have a collar: if one comes off, you will still know which puppy it is because it will be the only one without a collar. Another simple, inexpensive and safe option is to use plastic scoubidou strands, which also exist in many different colours.

Identifying the newborns enables careful monitoring of individuals at risk

5.2. THE GENERAL EXAMINATION

The physical examination should be performed from head to tail. Mortality due to congenital abnormalities in puppies and kittens accounts for about 5%. The first step is to **look for any visible congenital anomalies,** particularly in terms of the shape of skull (including the hydrocephalus, which will make the upper part of the head appear very round due to an increase in volume); cleft palate (examine the roof of the mouth as well as the bottom of the oral cavity); failure of the vertebral column to close (visible in the dorsal area, particularly towards the end of the spine); the presence of the anus or any visible oedema. While a large number of congenital defects have been described in canine and feline species, cleft palate is found most often at necropsy.
Large differences exist between breeds for the predisposition to some genetic and congenital diseases. Nowadays, **many laboratories offer genetic tests for genetic disease screening,** which means that positive animals can be excluded from the breeding programme.

Frequent gross malformations in puppies and kittens

Cleft palate	A cleft palate is when the roof of the mouth contains an opening into the nose. This disorder can result in feeding problems, food aspiration into the air-ways, infections and death
Head abnormalities	Accumulation of cerebrospinal fluid (hydrocephalus), protrusion of brain substance through a congenital opening of the skull (cephalocoele) or hemispheres completely missing or reduced to small masses (anencephaly or microcephaly)
Anasarca	A gross oedema of the entire body of a foetus/newborn
Limb abnormalities	Missing or deformed limbs
Spina bifida	Incomplete closing of the backbone and membranes around the spinal cord
Omphalocele (umbilical hernia)	Abdominal wall defect in which the intestines, liver, and occasionally other organs remain outside of the abdomen in a sac
Atresia ani	Absence or closure of a normal anus opening
Renal abnormalities	Missing or undeveloped kidneys (urinary agenesis/dysgenesis), polycystic kidneys
Intestinal atresia	A segment (usually small) of the small intestines is missing, leading to an intestinal obstruction
Cardiac abnormalities	Ventricular septal defects and atrialventricular canal defect, dysplasia of the mitral or tricuspid valves, aortic stenosis

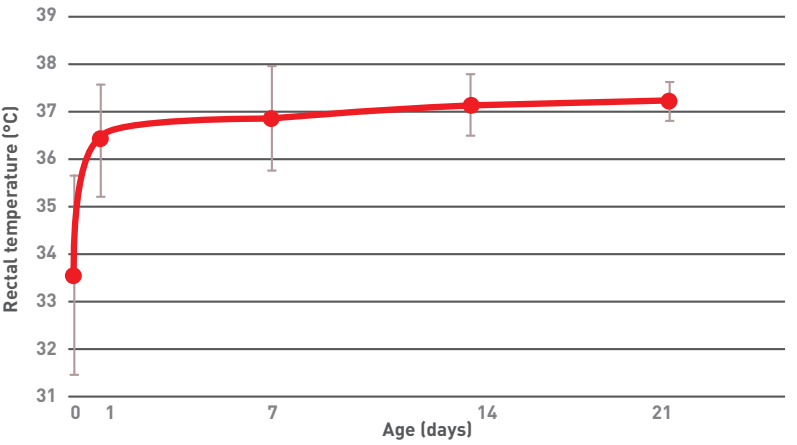
5.3. EVALUATION OF BODY TEMPERATURE

Temperature is one of the crucial elements of clinical monitoring for puppies and kittens, particularly because **the digestive ability of the newborn is directly affected by its temperature** (below 35°C, milk is not digested, in which case bottle-feeding cannot save a puppy if it remains at this temperature).
It is recommended to use a paediatric thermometer with a flexible tip to limit discomfort, with a temperature range starting at 32°C. Immediately after the birth and within the first few hours, rectal temperature can fall below 35°C (on average, it is 35°C during the eight hours after birth). The drop in body temperature during the first hours of life is a protective mechanism, related to the decreased metabolism in a situation of hypoxia. Survival time increases as the metabolic rate decreases. Body temperature generally increases during the first few hours, once the newborn is breathing normally. Approximately 24 hours after the birth, a healthy puppy will have a temperature of 35-36.5 °C (an average of 36.4°C). **Every time the temperature is taken, the anus must be checked for patency, swelling, redness and the appearance of faecal smear.**

A non-contact thermometer can be used for puppies but interpretation values differ from the values obtained with a rectal thermometer.

Pediatric thermometer with a flexible tip

Evolution of rectal temperature of the newborn between birth and 21 days NeoCare, ENVT



5.4. EVALUATION OF THE APGAR SCORE

The APGAR score is a method enabling evaluation of the puppies at risk of neonatal mortality. This system was developed for human babies by the American anaesthetist Virginia APGAR in the 1950s and is now commonly used to assess the health of a baby during the first minutes after birth. The acronym "APGAR" has since been defined **("Appearance, Pulse, Grimace, Activity, and Respiration")**, indicating the parameters to be observed, and the scoring system adapted to certain animal species, notably puppies.

How is it measured?

The APGAR score is composed of **heart rate** (bpm), **respiratory rate** (respirations/min), **response to stimuli,** activity, and **colour of the mucosa.** Reflex irritability is not easy to determine in neonatal puppies. It is best evaluated by pressing the tip of a paw and evaluating the strength of the reaction:

- quick leg retraction and crying 2 pts
- weak leg retraction and weak crying 1 pt
- no leg retraction and no vocalization 0 pt

APGAR scoring after Veronesi et al. (2009), modified. For each of the five parameters, a rating of 0 to 2 is given, then the total of the five ratings gives the APGAR score.

- Score 7-10: no distress
- Score 4-6: moderate distress
- Score 0-3: severe distress.

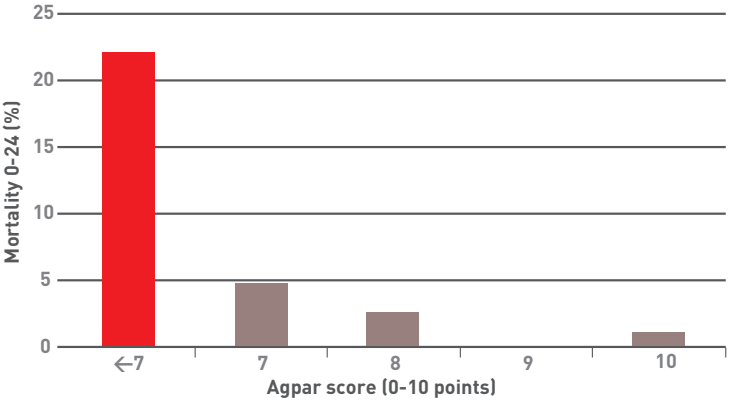
Parameter	Score		
	0	1	2
Heart rate (bpm)	<180	180-220	>220
Resp. rate/ min	<6, absence de pleurs	6-15, pleurs faibles	>15, pleurs
Reflex irritability	absent	grimace	vigorously
Motility	flaccid	flexions	active
Mucus color	cyanotic	pale	pink

5.4.1. APGAR AND THE RISK OF EARLY DEATH

Within the first few hours after birth, this inexpensive test, which is easy and quick to implement (less than a minute), enables identification of the puppies at the greatest risk of neonatal mortality, enabling the provision of suitable care. Carried out during the first few minutes of life, it enables rapid implementation of resuscitation techniques and evaluation of their effectiveness.

However, unlike with human babies, the score retains a good diagnostic value for puppies if implemented during the first eight hours of life. It is therefore compatible with conditions in a breeding facility. A recent study involving 347 puppies revealed a relationship between the APGAR score (measured during the first eight hours of life) and the puppy's chances of survival for the first 24 hours. Puppies with a score under 7 had a much higher risk of mortality than the others. The mortality rate was 22% in puppies with a score < 7 and only 1% in puppies with a higher score. The APGAR score does not, however, enable evaluation of the mortality risk over the first 21 days, only the first 24 hours.

Importance of the APGAR score for evaluating the risk of death within the first 24 hours of life. The APGAR score was evaluated within the first 8 hours of life on 347 puppies. NeoCare, ENVT



The mortality risk of puppies with an APGAR score under 7 was multiplied by 22.

Examination during the first few hours of life, based on the **APGAR score, rectal temperature, weight** and particularly the **search for congenital anomalies,** will **enable identification of the newborns that required specific resuscitation within an hour of birth,** as well as the **puppies that will require particular monitoring over their first three weeks.** Other information can then be obtained during the first two days of life to refine the early detection of puppies at risk.

MORE INFORMATION

MILA H, GRELLET A, FEUGIER A, CHASTANT-MAILLARD S. Differential impact of birth weight and early growth on neonatal mortality in puppies. J Anim Sci. 2015;93(9):4436-42.

VERONESI MC, PANZANI S, FAUSTINI M, ROTA A. An Apgar scoring system for routine assessment of newborn puppy viability and short-term survival prognosis. Theriogenology. 2009;72(3):401-7.

6 COLOSTRUM INTAKE AND PASSIVE TRANSFER OF IMMUNITY

6.1. IMMUNITY AND GLYCAEMIA: TWO IMPORTANT PARAMETERS FOR THE FIRST FEW DAYS

• Glycaemia in newborns

Puppies and kittens are predisposed to hypoglycaemia at birth. As a rule, puppies have low glycogen reserves. Glycogen is decomposed quickly, **making it very important that the newborns receive maternal milk immediately to prevent very low glycaemia at the end of their first day.** The metabolism of a newborn is less able to produce glucose than that of an adult, implying larger requirements. If they do not eat, the glycogen reserves will dwindle rapidly. Surprisingly, these minimal reserves enable a stable level of glycaemia to be maintained in a newborn puppy that does not eat for up to 24 hours after birth. Thereafter, the ability to maintain a normal glycaemic state is limited. The immature liver of a newborn is not efficient enough to produce the energy required.

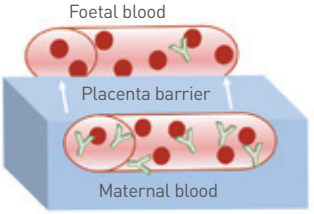
A large drop in glycaemia can also cause other problems, such as hypothermia and endotoxemia. Up to the age of 6 days, the puppies must produce body heat by thermogenesis without shivering, by releasing catecholamines (notably adrenalin) and lipolysis of the adipose tissues. This process demands a great deal of energy and can easily result in hypoglycaemia in a newborn. Sick or stressed puppies can also develop hypoglycaemia. Other conditions, such as a blood infection (or sepsis), a vascular anomaly (or portosystemic shunt) or a hepatic enzyme deficiency (different types of glycogen storage disease) can also cause a fall in glycaemia. The clinical signs include lethargy, inability to suckle, listlessness, depression or confusion, seizures, trembling, anxiety, vocalisation, irritability and even death. **The smaller the puppy, the greater the risk of suffering hypoglycaemia.**

• Immunity in newborns

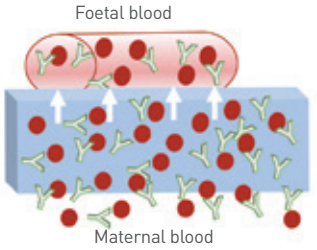
During the first two to three weeks of life, the newborns have a functional immune system but are **unable to produce antibodies in sufficient quantities.** This makes them unable to defend themselves against external microbial attack. During this very early period of their lives, the mother compensates for this incapacity, transferring some of her defences to the puppy. This is **"passive immunity transfer."** The way in which the mother transmits these antibodies varies from species to species.

In some species, particularly primates (including man) and rodents, the mother passes the antibodies to the young mainly during gestation: the placenta, an exchange system between mother and foetus, has a structure (called haemochorial) that enables the transfer of these elements. At birth, the young already have 75% of their immune defences. In dogs and cats, the placenta is different –endotheliochorial-: it hardly enables any passage of macromolecules (such as antibodies). The puppy has less than 10% of the required defences in its blood at birth. **Colostrum is the main contributor to developing immunity in newborn dogs and cats.**

Placentation difference between carnivores (dog and cat) and primates
There are more tissue layers separating the mother's blood from the foetus' blood in carnivores than in primates. This structure makes the carnivore's placenta almost impermeable to large-sized molecules



Carnivore placentation



Primate placentation

A precious liquid secreted by the mother enables kittens and puppies to acquire immune protection (which they do not have at birth) as well as providing a vital source of energy: COLOSTRUM.

6.1.1. GROWTH BETWEEN BIRTH AND TWO DAYS, AN IMPORTANT INDICATOR OF HEALTH

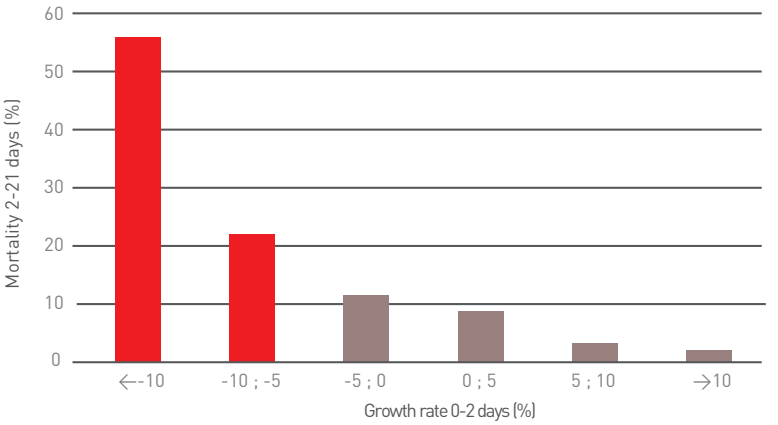
Growth between birth and the age of two days is an important indicator of the puppy or kitten's state of health and his chances of surviving until the age of 21 days. It is assessed by the growth rate, the percentage being calculated as follows: (weight at 2 days old – birth weight)/birth weight x 100. Although a 10% loss of birth weight is commonly considered to be physiological and tolerable in 2-day-old puppies, **it has recently been demonstrated that negative growth rate during the first two days of life is associated with a higher risk of neonatal mortality** (over the first 21 days of age). The cut-off value of early growth rate defining at-risk puppies is - 4%. In studied populations, almost 40% of puppies with the retarded growth died during the neonatal period, versus only 5% of puppies with correct growth rate. Overall, 30% of puppies suffer an energy deficit after the first two days and are therefore at risk of neonatal mortality.

Negative growth may suggest inadequate intake of colostrum, pivotal for the newborn dog, both for energy supply and passive immune transfer. The growth rate is correlated with the blood concentration in glucose in 24-hour old puppies (energy intake indicator) and with the blood concentration in G immunoglobulin (antibodies, indicating the acquisition of passive immunity (see below).

Weighing at birth and at 2 days old therefore enables indirect evaluation of the consumption and absorption of colostrum. It is only an à posteriori evaluation but offers the advantage of identifying the puppies that require particular monitoring over the coming weeks. Colostrum consumption during the first few hours of life is essential to improve the puppies' and kittens' chances of survival.

Early growth rate can be used to evaluate the quality of passive immune transfer

Relationship between the growth rate between 0 and 2 days and neonatal mortality (n=149 puppies). Growth rate was calculated according to (weight on day 2 – birth weight)/birth weight x 100.



Puppies with a weight loss ≥ 4 % between 0 and 2 days have an 8 times higher risk of death

MORE INFORMATION

Münnich A, Küchenmeister U, 2014 (Reprod Dom Anim 49 ,Suppl 2: 64-74)

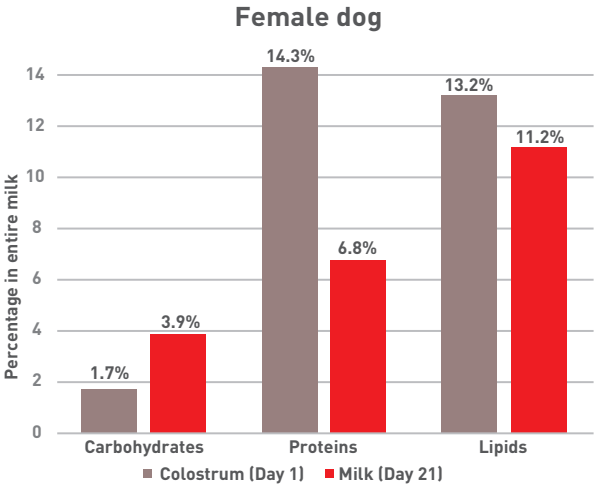
6.2. DIFFERENCE BETWEEN COLOSTRUM AND MILK

During the second month of gestation, the hormonal balance does not allow the secretion of milk. It is only at birth (particularly due to the fall in progesterone level) that the mammary glands start to secrete (very occasionally, before birth). **The first secretion is colostrum, produced after the birth.** The amount produced is not known; all we know is that during the first week after birthing, a cat produces the equivalent of 4-5% of her weight in milk (so for a 4kg cat, a daily milk production of 160-200ml).

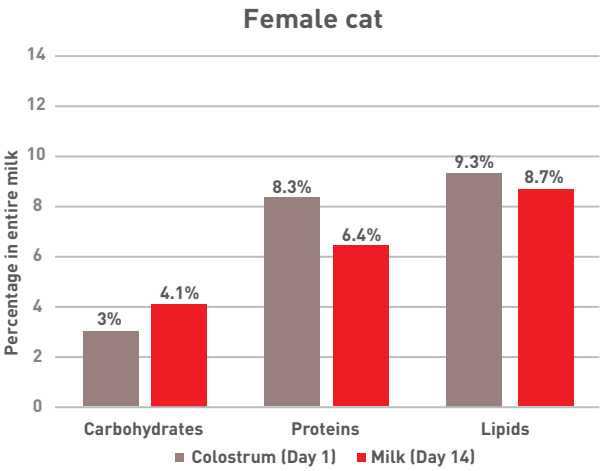
Colostrum is yellowish in colour, thicker and more viscous than milk, but the main difference between the two is the composition. The highly specific composition of colostrum is maintained in the lactating dog or cat for two days, after which, milk is produced.

The characteristics of colostrum compared with milk are different in dogs and cats. Canine colostrum is much richer in protein (twice as much protein as the milk produced two weeks after birth), slightly richer in lipids (+10%) but contains much less carbohydrate (half that of milk). Feline colostrum contains only 10% more protein than the milk, only 5% more lipids and a much lower carbohydrate concentration (-25%).

Difference in composition between colostrum and milk in dogs (from Adkins et al, 1997)



Difference in composition between colostrum and milk in cats (from Adkins et al, 1997)



SUCKLING BEHAVIOUR IN PUPPIES AND KITTENS

Within the first hours after birth, canine and feline neonates crawl to reach teats. A competition between siblings is observed in kittens, but not clearly evidenced between puppies. In parallel, a nipple preference develops in kittens during the first three days (meaning that each kitten will essentially suckle from one given teat), whereas such mammary appropriation does not appear in puppies : during each suckling session, puppies use on average 2.5 nipples and in one quarter of feeding sessions, at least one puppy does not even attach at all. However, the kittens grow at the same rate regardless of which teat they prefer. The first pair of mammary glands (anterior, out of five) is rarely used and puppies are found attached most often to the second and third pairs ; in queens, more than 50% of the suckling time is spent on the two caudal pairs.

6.3. IMPORTANCE OF COLOSTRUM IN TERMS OF IMMUNITY

One of the main characteristics of colostrum is its immunoglobulin content (Ig – the antibodies). Immunoglobulins represent between 20 and 37% of the colostral proteins. Three categories of Ig are found in canine colostrum (IgG, IgM and IgA), IgG being most common (60-75% of Ig) and IgE being undetectable.

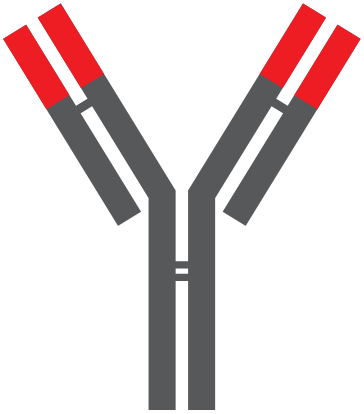
6.3.1. G IMMUNOGLOBULINS

6.3.1.1 G IMMUNOGLOBULINS IN THE COLOSTRUM

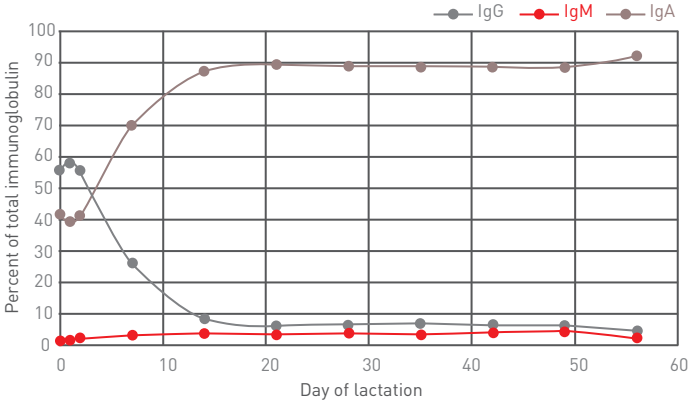
The concentration in IgG is 10 to 20 times higher in colostrum than in milk, in both dogs and cats: around 15-30g/L in canine colostrum, it drops very quickly (5g/l on D7 and less than 1g/l on D14). Most IgG comes from the mother's serum. During the final weeks of gestation, in the developing mammary tissue, the mammary cells draw G immunoglobulins (IgG) from the mother's blood. These IgG, fixed to specific receivers (called FcRn), are stored in the mammary cells.

The teat concentrates the IgG between the maternal serum and the colostrum: IgG concentration is three times higher in the colostrum than in the maternal serum (between 0.9 and 6.3 times, depending on the female). However, there is no link between colostral concentration of IgG and maternal serum concentration. The maternal Ig in circulation stored in the mammary glands towards the end of gestation is then released in the first secretions after birthing.

Structure of a G immunoglobulin



Evolution of the proportion of IgG, IgA and IgM in the colostrum and milk during lactation



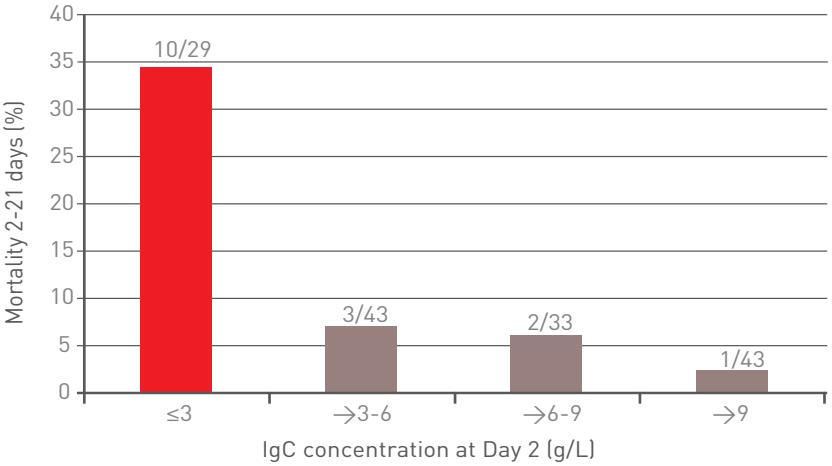
Intake of colostral Ig is absolutely crucial for puppies and kittens. They are born with next to no Ig in circulation: concentration is around 0.3g/L in puppies (and even less in kittens), compared with 8-25g/L in an adult dog. This is due to the structure of the placenta of female carnivores (endotheliochorial), making it almost totally impermeable to large-sized molecules, such as immunoglobulins. **The consumption of colostrum, rich in Ig, therefore enables the newborn to acquire immunity: this is described as passive acquisition of immunity,** since the Ig are simply received and not synthesized (active immunity) by the newborn. 85-95% of Ig in the circulatory system of a 2-day old puppy come from colostrum, and this figure can be up to 97-99% in kittens. At the age of 2 days, i.e. after colostrum intake, the puppy's blood concentration in IgG reaches 6g/L, which is roughly the same concentration as in an adult, if not slightly higher.

6.3.1.2 PASSIVE TRANSFER OF IMMUNITY

IgG ensures systemic immunity, i.e. for the body as a whole via the general circulatory system. The quality of passive immune transfer is classically evaluated through IgG concentration in neonates' blood at 2 days of age. **If the passive immunity transfer is insufficient, the risk of death within the first 21 days of life is increased. Immunity transfer is insufficient in approximately 20% of puppies.**

In puppies, the minimal threshold for IgG concentration has been determined at 2,3 g/L: puppies with blood IgG concentrations lower 2,3 g/L are at higher risk of death during the neonatal period. About 40% of puppies with IgG concentration below the threshold (≤ 2,3 g/L) die during the neonatal period, versus only 5% of puppies with adequate passive immune transfer. **The risk of neonatal mortality in puppies lacking passive immunity is therefore multiplied by 9.** The IgG threshold defining the quality of passive immune transfer is currently not defined in kittens. Ig dosage is still at the stage of laboratory research for the moment, and is not available in practice.

Importance of passive immune transfer for puppies' survival. Influence of IgG concentration at 2 days of age on neonatal mortality (n=149)



Passive immunity transfer via colostrum intake is insufficient in 20% of puppies.

HOW TO ENCOURAGE ADEQUATE CONSUMPTION OF COLOSTRUM

- Free the airways to develop the suckling reflex
- Ensure the teats are clean
- Put newborns to the teat as quickly as possible after birth
- Monitor the mother's behaviour
- Encourage the production of colostrum by limiting stress, ensuring that the mother gains weight during gestation (what %), reducing pain (management of the birth, Caesarean section).

How to encourage passive immune transfer

The quality of the puppy's passive immunity depends on the amount of colostrum ingested, the immunological quality of the colostrum ingested and the rapidity of the colostral intake after birth.

Time of colostral intake

Colostrum must be ingested during the first eight hours of life. There are two reasons for the need for early ingestion: **in the mother, the Ig concentration of the colostrum falls quickly in the hours immediately after birthing** (the immunological quality of the colostrum drops rapidly) and **in the puppy, the wall of the small intestine becomes less permeable to Ig.** This is closure of the intestinal barrier. At birth, the puppy absorbs an average of 40% of the ingested colostral IgG, but only absorbs 20% 4 hours after birth and 9% 12 hours after birth. From 24 hours after birth, absorption is zero. **The situation is similar in cats,** with closure occurring between 12 and 16 hours after birth. As well as being rich in Ig, colostrum also contains trypsin inhibitors. Trypsin is a digestive enzyme responsible for breaking down protein: breakdown of the Ig proivded by the colostrum is therefore diminished in the newborn's digestive tract, thus potentially increasing its absorption.

Immunological quality of colostrum

The immunological quality of the colostrum (in the sense of IgG concentration) is highly variable from one dog to another. It varies by a factor of 5 between the highest and lowest concentrations, although the determining factors of this quality are unknown: the mother's age, breed size, and size of litter do not appear to have any impact. The immunological quality of the colostrum also **varies significantly between the pairs of teats on the same female** (variations of a factor of 2). However, **the pair of teats producing the best quality colostrum is not always the same, depending on the female.** It is therefore not possible to advise suckling one teat or another to guarantee ingestion of colostrum of good immunological quality. **The high level of variation of immunological quality among mothers and between the teats of one mother is therefore liable to expose certain litters or some of the puppies from a single litter to a greater risk of neonatal mortality.**

Aside from the fact that the mother must produce a sufficient quantity of colostrum for the entire litter, the newborn must also be able to suckle. The mother's behaviour and teat arrangement must therefore be checked.

6.3.2. THE OTHER IMMUNOGLOBULINS

Unlike Ig, the two other categories of Ig present in the colostrum, IgA and IgM, seem to be mostly produced locally in the mammary glands (by the lymphocytes). IgA represents 16-40% of colostral Ig, before becoming largely predominant in the milk. A fraction of colostral IgA is absorbed into the puppy's general circulatory system, like IgG, but IgA is very quickly passed from the blood to the mucous tissues of the body, particularly the digestive and respiratory tracts. **The IgA provided by the colostrum thus contributes to local defence of the digestive tract and respiratory system.**

6.3.3. OTHER IMMUNE FACTORS

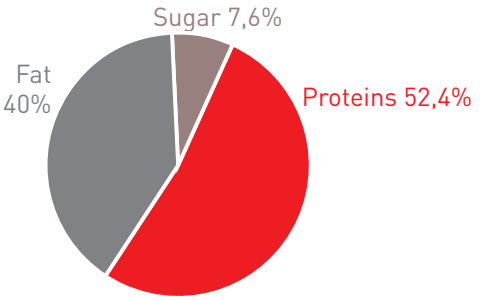
The colostrum also contains anti-microbial factors, such as lactoferrin or lysozyme. However, the colostral lactoferrin only appears to play a minor role in puppy immunity. The colostrum also contains immune cells (white line: macrophages, granulocytes neutrophils, lymphocytes). These cells pass through the intestinal wall and into the circulatory system of the newborn, where they intervene in local digestive immunity. These cells can phagocyte and destroy the digestive pathogens, but also produce IgA. Their actual importance has not yet been clearly defined.

6.4. IMPORTANCE OF COLOSTRUM IN TERMS OF ENERGY

Separated from the placenta that ensured a constant supply of nutrients, the newborn depends solely on the colostrum ingested to meet its growth requirements and, first and foremost, its energy needs. The energy provided by the colostrum is essential from the very first hours of life, because of the very low adipose tissue reserves that carnivores have at birth, aggravated by their limited capacity for glycogenolysis. The newborn can only grow if intake exceeds its maintenance level requirements. As explained previously **the energy provided, evaluated indirectly via the growth rate between birth and the age of 2 days, is one of the decisive factors of newborn survival.**

The energy value of the colostrum is 20% higher than that of milk in dogs, and of equivalent value in cats. 50% of the energy provided by the colostrum comes from protein and 40% comes from lipids, while carbohydrates play only a minor role. Energy value differences are mainly explained by variations in the level of lipids. The energy value of the colostrum varies within a relatively limited range from one dog to another (a factor of 1.6) and varies little from one pair of teats to another on the same dog; the age of the dog, breed size and litter size have no impact. Overall, the energy value is therefore much less variable than the immunological quality and the two factors of colostrum quality are not correlated.

Energy supplied by the colostrum



QUANTITY OF COLOSTRUM TO BE INGESTED TO COVER IMMUNITY REQUIREMENTS

The quantity of colostrum to be ingested to cover the immunity requirements of a puppy can be calculated as 1.3ml of colostrum per 100g of live weight. The average quantity of colostrum to be ingested to cover the energy requirements is 12ml/100g for a puppy. In kittens, the quantity of colostrum required to cover the immunity requirements is three to four times less than that required to cover the energy requirements. Although it would therefore seem much more difficult to cover the energy requirements than the immunological requirements, only a slightly higher proportion of puppies ends up deficient in terms of energy (30%) compared with Ig (20%).

6.5. IMPORTANCE OF COLOSTRUM IN TERMS OF ORGAN DEVELOPMENT AND MATURATION

As well as increasing weight, the colostrum is also involved in the development and maturation of certain organs, particularly the digestive system. The colostrum contains hormones (cortisol, thyroxin, insulin, growth hormone) and growth factors (insulin-like growth factors, epidermal growth factor, nerve growth factors), which contribute, among other things, to the development and maturation of many organs (thyroid, intestines) as well as to overall growth of the newborn.

6.6. RISKS LINKED TO THE INGESTION OF COLOSTRUM

Colostrum is a solution of original composition crucial to the survival of the newborn. It not only **provides defences to fight pathogens,** but also **provides all the nutrients necessary for good development and optimal growth.**

However, the colostrum can also be a factor of risk for neonatal mortality. **Certain pathogens or toxins can be passed on from the mother to the newborn via the colostrum.**

6.6.1. TRANSMISSION OF PARASITES

Certain parasites can be passed on to the newborn by ingestion of colostrum. *Toxocara canis, Toxocara cati,* and *Ancylostoma caninum* are digestive parasites whose larvae can migrate into various tissues, including the mammary glands of the female, and thus into the milk. The larvae are then absorbed by the suckling puppy or kitten, passing through the digestive mucosa and into the blood stream to reach the lungs. They make their way up to the buccal cavity before being swallowed, passing into the digestive tract where they become worms. The puppies and kittens can therefore present pneumonia associated with a cough due to larva migration, followed by digestive disorders, to the extent of obstruction once the worm reaches adult size, and delayed growth. **Diagnosis is possible by coproscopy. Premises must be kept hygienic** and a **de-worming protocol** established before mating: t**he molecule and the de-worming period are important.** The larvae remain quiescent in the tissues and are reactivated during gestation. Once in the tissues, they are resistant to de-worming products, which is why treatment must be administered at the time of reactivation. Additionally, humans can also be infected with these parasites. Good de-worming of the breeding facility reduces the risk of transmission to man.

6.6.2. TRANSMISSION OF VIRUSES

The colostrum can also be the transmission vector for two viruses (of the Retrovirus family) in cats: FelV **(feline leukaemia virus)** and FIV **(feline immunodeficiency virus)** or cat AIDS. The retrovirus integrates into the genome of its host enabling replication. If it is not eliminated before integration into the genome, it will become latent (actual or clinical latency). Kittens infected with FIV will suffer fading kitten syndrome, because this virus attacks the thymus (important to the development of the immune system). FelV infection often goes unnoticed (although fever and lethargy might be observed).

However, the cat generally remains asymptomatic for months, even years; malfunction of the immune system develops gradually. No treatment is available at present. Contamination is not only via milk, but also via other body fluids. Removing the kittens at birth is not effective in preventing infection since they can be infected in utero or during birthing. **Prevention therefore demands systematic screening of the parents (PCR or snap test) and their removal from the breeding programme if the test results are positive.**

6.6.3. TOXIC MILK SYNDROME AND MASTITIS

Toxic milk syndrome is a bacterial infection in puppies and kittens which are contaminated by ingesting colostrum or maternal milk. The toxic milk is related to **an infection of the mammary gland** (mastitis) due to an ascending infection related to poor conditions in the breeding facility, **injury to the mammary gland** caused by the newborns or the environment. This toxic milk can also be caused by a toxin transfer (a toxic substance produced by bacteria) from the blood to the milk if the mother has a systemic illness (general), but this is relatively rare.

An inflammation (redness, swelling, pain and heat) of one or more teats may be observed, associated with weakening of the newborns. Toxic milk syndrome should be suspected in this case. However, sub-clinical mastitis (mastitis causing no other symptoms) may also be the cause of a newborn wasting away for no apparent reason. The appearance of the milk can also raise suspicion of mastitis: normal milk is yellowish (colostrum) or white (milk), milk that is yellow-green indicates the presence of pus and a red-brown colour indicates the presence of red and/or white blood cells. **The clinical signs of infected puppies or kittens include crying, digestive disorders, lack of growth (or even weight loss), weakness, septicaemia and death.**

A smear test on a drop of milk can be carried out to search for white blood cells and bacteria. **A bacteriological analysis is often carried out to detect the presence of bacteria in the milk and identify the pathogen involved.** Commonly isolated bacteria are environmental bacteria (Streptococcus, E. Coli and Staphylococcus). Early treatment of the mother and withdrawal of the newborns is recommended to avoid this toxic milk syndrome. The young must then be adopted by another lactating female or fed with formula milk. **Preventive measures include ensuring that hygiene in the facility and of the teats remains constant. It is also possible to trim the claws of the newborns.**

6.6.4. TRANSMISSION OF MEDICATION

Many drugs can be excreted in the milk and absorbed by the newborn, potentially with tragic consequences. Some molecules may impair growth in puppies or kittens, while others may have toxic consequences on the kidneys or liver. Thus, **if disease is present you should consult your vet to adapt treatment to the maternal state.**

6.6.5. NEONATAL ISOERYTHROLYSIS

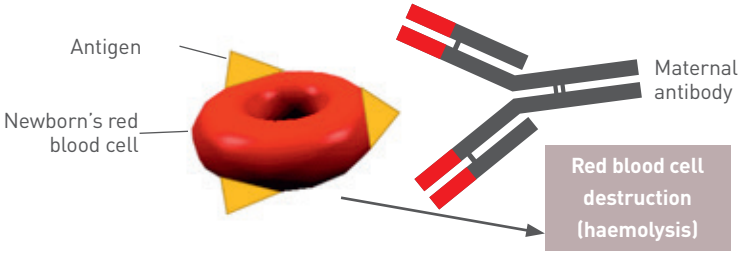
Neonatal isoerythrolysis is a disease affecting newborn kittens after absorption of colostrum. It also occurs in puppies but only very rarely. The **kitten's red blood cells** (erythrocytes) **are destroyed by the mother's antibodies contained in the colostrum.** This illness is due to **incompatibility between the blood groups of the mother and newborn.**

Cats have three possible blood groups: A, B or AB, depending on their genetic makeup. The gene with the blood group coding has 2 alleles, A and b, and their combination defines the individual's blood group. Allele A is dominant over allele b. If A is present, the red blood cells have the A antigen (a protein) on their surface and if the b allele is present, they have the B antigen. Cats in group A therefore have the AA or Ab genotype and the red blood cells only have the A antigen; cats in group B can only have the bb genotype and therefore only have the B antigen on their red globules. Cats in group AB are extremely rare in the feline population (frequency lower than 1%). The transmission mode remains uncertain, but seems to be linked to the presence of a third allele (AB), dominant over b but dominated by A. The red blood cells of these AB group cats have A and B antigens.

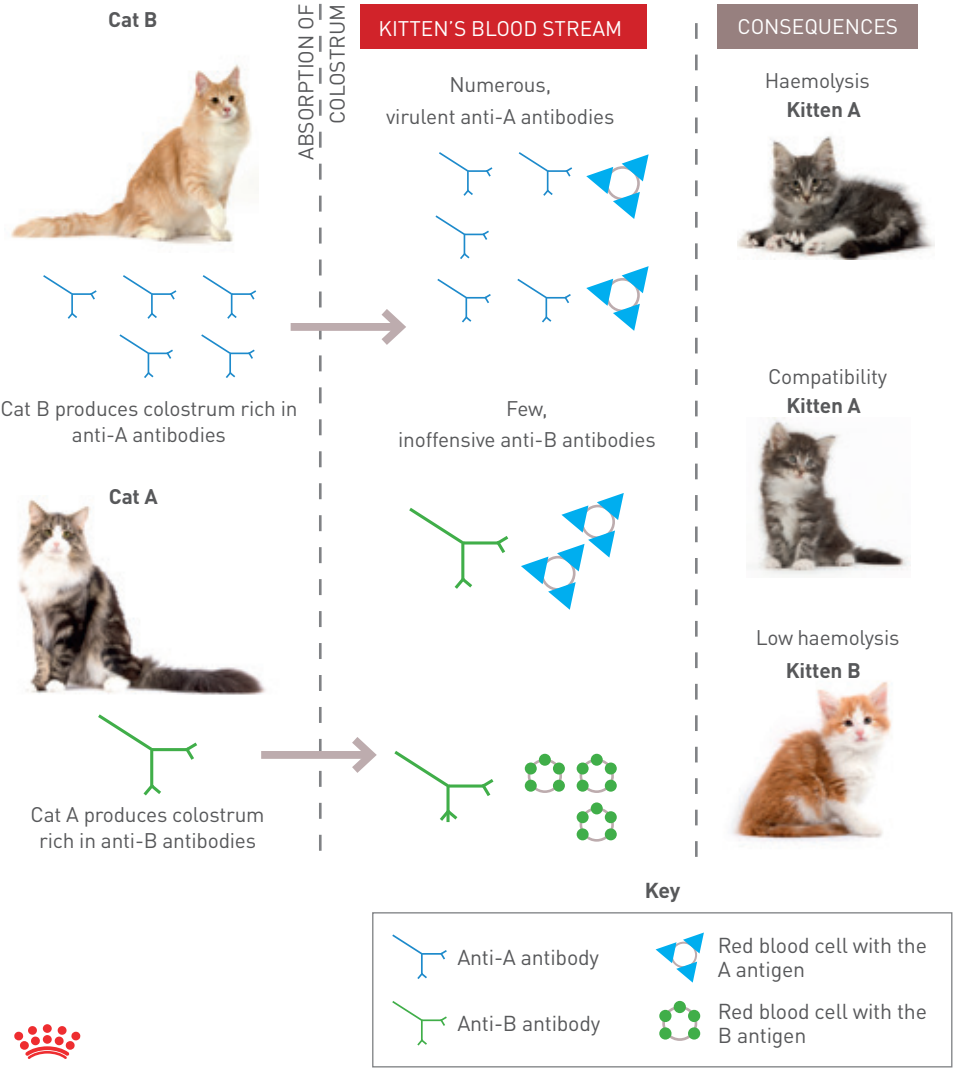
6.6.5.1 ISOERYTHROLYSIS MECHANISM

Group B cats spontaneously (i.e. specifically, even before the first gestation) have blood antibodies directed against the A antigen (group A cats have anti-B antibodies, but these are more or less harmless). After birthing, the mother produces colostrum with anti A antigen antibodies. **Neonatal isoerythrolysis appears in litters of B (bb) group females and A (AA or Ab) group males;** the kittens have either the Ab or bb genotype and **neonatal isoerythrolysis appears in Ab kittens whose red blood cells have both A and b antigens.** If these Ab kittens ingest their mother's colostrum containing anti-A antibodies, the antibodies will be absorbed and pass into the kittens' blood stream. They will attach themselves to the red blood cell antigens, causing destruction (haemolysis) and agglutination.

Recognition of blood group antigens on the red blood cells by the colostral antibodies.



Neonatal isoerythrolysis mechanism



6.6.5.2 HIGH RISK MATINGS

Only litters from a B group female present a risk of neonatal isoerythrolysis. Depending on the genotype of the parents, the proportion of the litter affected (on average), and therefore the risk of neonatal isoerythrolysis, varies. Thus, all the kittens of a litter produced by a bb female and an AA or ABAB male will be at risk, compared with 50% of the kittens of a litter from a bb female and an Ab or ABb male.

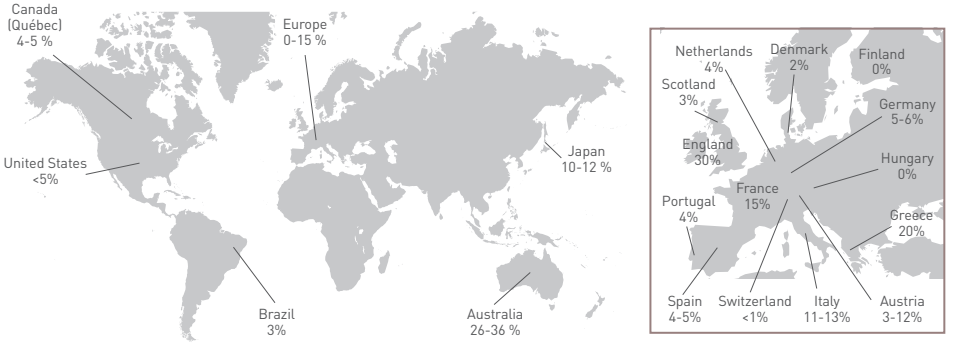
6.6.5.3 EVALUATION OF THE RISK OF ISOERYTHROLYSIS

Although the most common blood group in the cat population is group A, **the frequency of group B varies from country to country:** 0% type B in Finland, 15% in France and up to 36% in Australia. It also **varies significantly from one breed to another:** 0% in Birman, Siamese and Tonkinese, compared with 46% in Angoras, 41% in Devon Rex, 40% in British Shorthair and 34% in Cornish Rex and up to 60% for the Turkish Van. **The AB phenotype is extremely rare in the feline population, and it's presence is proportional to frequency of the B group.** Thus, depending on the frequency of B group in a breed, the risks of neonatal isoerythrolysis for a litter can vary significantly.

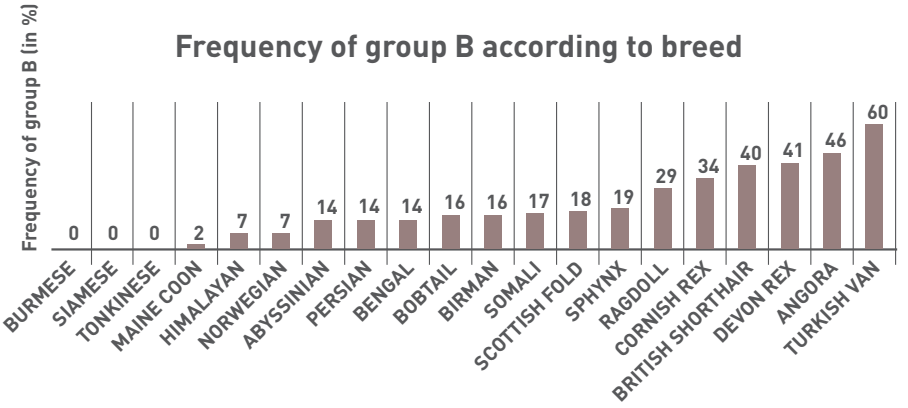
Genotype of kittens from different crosses – Genotypes of kittens at risk of neonatal isoerythrolysis in red. Genitors whose crosses result in litters at risk of neonatal isoerythrolysis in black.

		[A]		[A]		[B]		[AB]		[AB]	
		A	A	A	b	b	b	AB	AB	AB	b
[A]	A	AA	AA	AA	Ab	Ab	Ab	AAB	AAB	AAB	Ab
	A	AA	AA	AA	Ab	Ab	Ab	AAB	AAB	AAB	Ab
[A]	A	AA	AA	AA	Ab	Ab	Ab	AAB	AAB	AAB	Ab
	b	Ab	Ab	Ab	bb	bb	bb	ABb	Ab	Ab	bb
[A]	A	AA	AA	AA	Ab	Ab	Ab	AAB	AA	AAB	Ab
	AB	AAB	AAB	AAB	ABb	ABb	ABb	ABAB	ABAB	ABAB	ABb
[B]	b	Ab	Ab	Ab	bb	bb	bb	ABb	ABb	ABb	bb
	b	Ab	Ab	Ab	bb	bb	bb	ABb	ABb	ABb	bb
[AB]	AB	AAB	AAB	AAB	ABb	ABb	ABb	ABAB	ABAB	ABAB	ABb
	AB	AAB	AAB	AAB	ABb	ABb	ABb	ABAB	ABAB	ABAB	ABb
[AB]	AB	AAB	AAB	AAB	ABb	ABb	ABb	ABAB	ABAB	ABAB	ABb
	b	Ab	Ab	Ab	bb	bb	bb	ABb	ABb	ABb	bb

Frequency of group B in the feline population according to country (according to Giger et Casal, 1997 / Fosset et Blais, 2014/ Forcada et al. 2007/ Malik et al. 2005/ Meideros et al., 2008/ Sylvestre Ferreira, 2004).



Frequency of group B in the feline population according to breed (according to Giger et Casal 1997, Knottenbelt et al 1999, Forcada/Arikan 2003).



6.6.5.4 CLINICAL SIGNS

During gestation, the foetus is not in danger because hardly any maternal antibodies get through the placenta barrier. The kitten is **born, apparently in good health,** and suckles her mother enthusiastically. **Her condition deteriorates within 48-72 hours of birth, following ingestion of colostrum.** The intensity of the symptoms varies, probably according to the quantity of antibodies absorbed, ranging from no signs at all to sudden death. Newborns will stop feeding and cease to gain weight. **Haemolysis** (destruction of the red blood cells) **induces anaemia** (pink mucosal tissue turns white), **icterus** (yellowish colouration of the mucosal tissues due to deteriorated haemoglobin) and **haemoglobinuria** (reddish-brown urine due to the haemoglobin released into the blood following haemolysis and filtration by the kidneys). The agglutination of the red blood cells after fixation of the antibodies causes blood clots that block the smaller blood vessels: necrosis of the extremities and tail, indicated by black coloration.

6.6.5.5 TREATMENT AND PREVENTION

Treatment requires hospitalisation, for a blood transfusion specifically. However, even if the kittens are withdrawn from their mother when the clinical signs first appear, and in spite of intensive care, the mortality rate remains high. **Neonatal isoerythrolysis must be prevented, by separating the kittens at risk** (i.e. A kittens of a B mother) **within 24 hours of birth** (after that, the intestinal barrier is closed and no longer permits the passage of antibodies from the digestive system into the blood; see below). The kittens are fed with a colostrum substitute (see below). The kittens' blood types can be tested, if necessary. Blood from the umbilical cord can be used to identify the kitten's blood group in order to assess the risks of neonatal isoerythrolysis after high risk mating.

Even further upstream, **prevention implies reasoned management of reproduction: B females must not be mated with A males.** In order to determine the blood group of the genitors, a blood sample can be taken and tested by your vet.

Blood group testing in felines (Quick Test®, Alvedia, Limonest, France)

Group A cat		A red line opposite the A arrow indicates a positive reaction for group A
Group B cat		A red line opposite the B arrow indicates a positive reaction for group A
Group AB cat		Two red lines opposite the A and B arrows indicates a positive reaction for group AB

MORE INFORMATION

GIGER U, CASAL ML. (1997) Feline colostrum-friend or foe: maternal antibodies in queens and kittens. J. Reprod. Fertil. Suppl.51, 313-316.

6.7. WHAT TO DO IF THE MOTHER PRODUCES INSUFFICIENT OR NO COLOSTRUM

Ingestion of enough colostrum of sufficient quality is a major asset for the survival of the puppies. However, in certain situations, the mother's colostrum may not be available – or only available in small quantities – or may even be toxic for the newborns. In such cases, **supplements or substitutes must be administered to limit the risk of neonatal mortality for the puppies and kittens.** Use of a supplement (if the newborns have access to a small amount of colostrum) or a colostral substitute (if there is no colostrum) is necessary for orphans, if the litter is too large, if the maternal milk is not suitable for ingestion (in the case of mastitis) or for cats, if the litter is at risk of isoerythrolysis (see specific section). In this case, the kittens must not ingest milk from their mother for the first 24-48 hours.

Generally speaking, when puppies or kittens fail to gain weight for two consecutive days or cry constantly, you should suspect that the mother's milk production is not sufficient to ensure growth of the newborns. **Again, weighing the young during the first two days of life is a simple but informative means of monitoring the newborns.**

Use of substitute milk is necessary in the following cases:
- orphaned animals
- large litter
- infection of the mammary gland
- no weight gain during the first two days
- behavioural disorder in the mother
- risk of isoerythrolysis (in cats)

Weight loss can be due to insufficient milk production or another underlying cause (viral or bacterial infection, toxic milk, etc.). It is therefore important to consult your vet in the event of unexplained weight loss in a puppy or kitten, to enable examination of its general condition and eliminate any underlying illness.

With very large litters, if insufficient milk production is suspected, it is recommended that formula supplements be provided to the entire litter, rather than withdrawing one or more individuals to feed them only with formula milk. Distribution of a colostral substitute also aims to provide energy to the puppies and kittens, at the very least, and, ideally, to provide them with immunoglobulins.

6.7.1. STIMULATING THE MOTHER'S MILK PRODUCTION

Before the birth, the right diet (see above) ensuring sufficient weight gain and allowing the future mother to **get accustomed to where she will be giving birth will encourage the production of colostrum** (and subsequently milk). If the secretion of colostrum is not triggered within a few hours of birthing, which can be the case, particularly after a difficult or first birth, the vet may suggest treatment. Such treatments mainly act against pain but also stimulate the production of colostrum or milk via medication.

However, before the treatment is effective, the newborns must be fed; moreover, immunoglobulins must be provided within the first twelve hours of life.
A number of colostral substitutes are available, either to provide energy or to provide immunoglobulins, but rarely both.

6.7.2. USING FROZEN CANINE OR FELINE COLOSTRUM

The ideal solution would obviously be to have another female that had birthed less than 2-3 days previously and either have her adopt the puppies, or to express and feed the colostrum to the orphan puppies.

However it can be difficult to have two females birthing so close together. One solution is to develop **a bank of frozen colostrum,** as is common on cattle and horse farms. Colostrum can be expressed from the dog the second day after birthing, i.e. after her own puppies have acquired their passive immunity, but before the milk comes. It is relatively simple to express a dog, but slightly more difficult for a cat because she is generally less cooperative and the teats are smaller. The skin is washed with a chlorhexidine solution before collecting the colostrum in plastic tubes with a volume of just a few millilitres. The tubes are then frozen (-20°C) and kept until required. If a litter needs colostrum, the tubes are defrosted to 37°C, but not in a microwave, as this would destroy the Ig. The colostrum is then administered using a bottle or an oesophageal feeding tube, at the dosage of 1.5ml per 100g body weight of the puppy. **The feeding tube must be inserted under supervision of a vet or after training supervised by a vet.**

6.7.3. USING MILK FROM ANOTHER FEMALE

If the birth was more than three days previously, the dog will be secreting milk and not colostrum. This milk, even one month after the birth, can provide adequate energy, since its energy value is only 20% less than that of colostrum. However, the IgG content will be largely insufficient: milk contains 1-2g/l of IgG compared with 20g/l in colostrum (see specific section). Milk from a lactating female must therefore be supplemented with Ig to attempt to transfer passive immunity; however, **adoption by another female has the combined advantage of providing energy for the newborn and ensuring its socialisation.**

ADOPTION BY A LACTATING FEMALE

To avoid use of formula milk, it is naturally preferable (if a mother is available at the same stage of lactation) to try and get another mother to adopt the puppy.
Rubbing the orphan against the offspring of the mother's own litter will transfer a smell, which seems to favour acceptance. During the first few days after birth, although the newborn is not particularly attached to its mother, she certainly recognises her own young.
Close monitoring is necessary to ensure that the puppies or kittens are well accepted by their new mother.
From the third week, growth food can be offered to the puppies gradually via a warmed bottle to supplement the mother's milk, production of which will be starting to decline. Some puppies spontaneously head for the feeding bowl and will start to lap, imitating the mother's feeding behaviour.

6.7.4. USING ADULT ANIMAL SERUM

Serum taken from an adult dog or cat is a source of "homologous" immunoglobulins, i.e. from the same species as the receiving animals. Furthermore, **if the adult is from the same breeding facility as the litter being supplemented, his serum will contain antibodies against the pathogens present in the facility.** However, even if the adult is vaccinated shortly before the blood sample, the Ig concentration in his serum will be approximately three times lower than that of colostrum. Its energy value is also very low.

Trials administering canine serum orally from birth to puppies deprived of colostrum report an increase in the level of IgG in circulation that is far below that obtained after ingesting colostrum. However, oral administration of 2 or 4ml of canine serum could enable newborns to attain the minimal threshold of IgG to control neonatal mortality (2.3g/l). In kittens deprived of colostrum, oral administration of adult cat serum does not increase the level of IgG in circulation.

Serum could also be used as a colostral supplement, i.e. administered to newborns suckling their mother, to boost the immune transfer and ensure ingestion of the minimal dose of Ig. However, this strategy does not reduce the number of puppies suffering an immune transfer deficit, nor an overall increase in transfer quality. **Serum is therefore neither a good supplement nor a good substitute for colostrum in puppies.**

Administering serum to a puppy

SUBCUTANEOUS OR INTRA-PERITONEAL INJECTION OF ADULT SERUM

Another option to increase the level of passive immunity in the newborn deprived of colostrum is a subcutaneous or intra-peritoneal injection of adult serum. Indeed, IgG concentrations in bloodstream of puppy and kitten supplemented via parenteral administration were higher than via the oral route in puppies and even comparable with the levels obtained thanks to the natural colostrum intake in kittens. However, subcutaneous or intra-peritoneal injection of the serum can be also a cause of neonatal mortality, as non-aseptic serum handling as well as inappropriate serum injection may cause necrosis and bacterial infection of the soft tissue around the injection site. Any attempt to use serum therapy in the newborns if needed should thus be performed by the vet.

6.7.5. USING COLOSTRUM FROM OTHER SPECIES

Large size females, such as cows, sheep and goats, selected for their milk production, also produce colostrum, but in much larger quantities than dogs or cats. Bovine colostral paste preparations, manufactured by partial dehydration of the colostrum, are available. The nutritional and particularly immunological advantages of such products have not been evaluated in newborn puppies and kittens. The energy provided mainly depends on the quantities administered and recommended by the manufacturer. In terms of immunity advantages, although bovine Ig is probably absorbed by the digestive systems of puppies and kittens, these immunoglobulins do **not provide any specific immunity.**

6.7.6. USING FORMULA MILK

Formula milk contains no canine immunoglobulins and has an energy concentration of around 1kcal/ml, i.e. half that of colostrum. **They therefore provide nutrition but do not offer any immunological benefit.**

6.7.7. A NEW SOURCE OF IMMUNOGLOBULIN: IGY

Chickens vaccinated against a specific pathogen produce large quantities of antibodies directed against this pathogen in the yolks of their eggs. This IgY (Y for "yolk") offers the advantage of being relatively easily available and being able **to be directed against canine pathogens** (by vaccinating the chickens against these pathogens).

When administered orally within the first eight hours of life to a puppy with free access to his mother's colostrum, **improved growth is observed during the first three weeks of life.** Oral administration of IgY to puppies before closure of the intestinal barrier is therefore promising in terms of overall health improvement. **If there is no colostrum available, IgY can be added to formula milk, which provides the energy required.**

7 MANAGEMENT OF PUPPIES AND KITTENS AFTER INGESTION OF COLOSTRUM

Neonatal health

Mating | Gestation | Birth | 0-2 days of life | 2-21 days of life

7.1. CLINICAL EXAMINATION OF PUPPIES AND KITTENS DURING THE FIRST FEW DAYS OF THEIR LIVES

The general clinical examination includes observation from head to tail. The oral mucosa must also be checked to detect any change in colour (cyanosis, anaemia, grey or pale appearance). In a healthy newborn, the oral mucosa looks hyperhaemic (highly vascularised: red) for the first week, before it starts to fade to pink. In the event of illness, presence of the suckling reflex must be assessed since this reflex is often lost in the case of infectious disease.

Normal hyperaemic oral mucosa in the first days

The examination procedures and biological signs are different for newborns and adult animals. Thus, a dehydration diagnosis in newborns, carried out on a skin fold, is not particularly relevant to very young puppies because the composition of their subcutaneous tissues is different from that of adults. The appearance of the oral mucosa has less diagnostic value in terms of the state of dehydration. Pale or dry, grey gums are much more indicative.

Skin fold in a healthy neonate: on the right after 4 seconds

In healthy puppies and kittens, breathing is easy and regular. The thoracic area must be examined to observe symmetry and any sternal or vertebral injury or anomaly (e.g., pectus excavatum). Puppies and kittens alike should have **good muscle tone** and **their navel must be carefully inspected** to detect any swelling, humidity (during the first few days), pus, inflammation or other sign of infection. The umbilical cord generally falls on the second or third day after birth. **The perineal region must also be examined carefully to** detect any signs of diarrhoea.

During the first few days, a healthy puppy is not expressive for more than 15 minutes at a time and sleeps approximately 90% of the time, over a 24-hour period.

Examination of the nervous system is difficult at such a young age. One of the signs of normal neurological **development is the expression of flexion as muscle dominance** (until day 4). From day 4, muscle dominance becomes extension, indicating normal development of the nervous system and good muscle interaction.

On the fourth day after birth, muscle dominance (flexion reflex) changes to the extension reflex: this is a sign of normal neurological development (left: puppy aged 2 days, right: puppy aged 10 days)

In the case of puppies suffering illness during the neonatal period, the mother must also be examined. It is important to ensure that she is not suffering delayed uterine involution, insufficient milk, subclinical mastitis, or any other source of bacterial infection for the newborn.

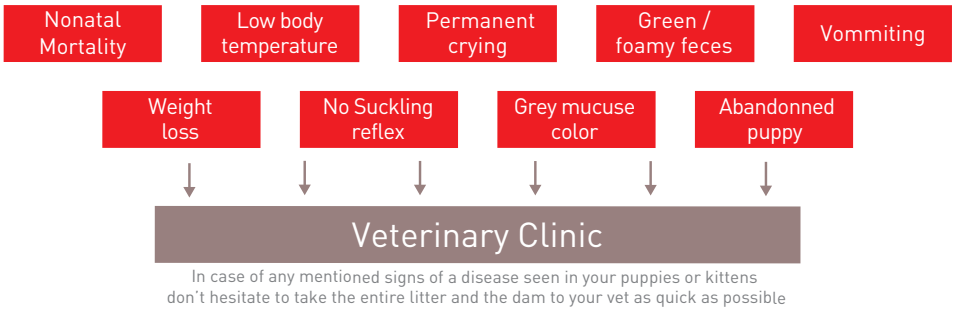
Additional examinations enable confirmation of the diagnosis and implementation of appropriate treatment. These examinations also permit the vet to make a prognosis and to implement preventive measures and possibly treatment for the rest of the litter, as necessary. The most common procedures are bacterial samples (bacteriology), blood samples for haematological and bio-chemical analysis of the blood, urine samples, ultrasound scan and X-ray.

Normal specific physiological features in neonatal puppies – what is the difference in comparison to adults?

Specific feature	Occurrence at the age of / with
Hypothermia (even greater than the normal evolution curve in the newborn)	0-4 weeks
Hyperaemic[1] mucous membranes	First week
Normal vision	After 4 weeks
Reduced drug metabolism	Up to 6 months (renal function)
Acidity of intestine, low HCl production	First weeks
No gag reflex[2]	Up to 10 days

1: Hyperaemia: presence of a large amount of blood in an organ, whose tissues therefore appear red instead of pink
2: Pharyngeal reflex: contraction of the pharynx muscle following sensorial stimulation of the receptors of the soft palate.

Summary of the main clinical signs indicating a problem



In case of any mentioned signs of a disease seen in your puppies or kittens don't hesitate to take the entire litter and the dam to your vet as quick as possible

The temperature of a newborn is physiologically lower than that of an adult, but it is essential that it be maintained to enable continuation of the suckling reflex and, most importantly, digestion. Maintaining a high temperature will also help the newborn fight infections. Normal temperature varies with age, therefore it is useful to refer to the reference graph.

7.2. THE MAIN CAUSES OF NEONATAL MORTALITY DURING THE FIRST FEW DAYS OF LIFE

Traditionally, distinction is made between infectious and non-infectious causes. However, these two main families are linked, firstly because they display similar symptoms and secondly because one can favour the appearance of the other. As already discussed, non-infectious causes **include hypoxia, hypoglycaemia, hypothermia and dehydration** (see specific section). These last three non-infectious causes also appear to be involved in many cases of other illnesses, as biological signs, as in the case of septicaemia or bacterial infection. Furthermore, mainly non-infectious illnesses regularly pre-dispose the newborn to infections. The mechanisms are complex and offer a clear indication of the **inter-relationships between infectious and non-infectious causes.** 40-50% of cases of neonatal mortality are due to infectious causes.

Main causes of neonatal mortality

Non-infectious causes	Infectious diseases
Hypoxaemia / Respiratory Distress (RDS)	Bacterial infections (Local, generalized bacterial infection, Sepsis/septicaemia)
Hypothermia	Viral infections
Hypoglycaemia, dehydration	Canine Herpes virus
Traumatic insults/injuries	Canine Minute Virus (MVC)
Toxic milk syndrome	Parasites
Non-infectious diarrhoea	
Malformations, defects	
Haemorrhage (Vit. K deficiency)	
Juvenile cellulitis Isoerythrolysis (in the kitten) Poor maternal behaviour Malnutriton	

Infectious diseases, and particularly bacterial illnesses, are **the most frequent cause of neonatal disease and death in newborns.** Newborn deaths due to bacterial infection are **highest during the first week.**

Bacteria normally colonise the newborn during the first few days of its life. In unstressful conditions, these bacteria are commensal (normal) and simply cause benign symptoms, such as self-limiting conditions or infections that remain invisible during the clinical examination.
Post-mortem results reveal that *E.coli,* Staphylococcus and Streptococcus are the main causes of illness and death occurring shortly after birth. However, samples taken from sick puppies and post-mortem samples often enable other responsible agents to be diagnosed, such as Pseudomonas, Klebsiella or Enterobacteriaceae.

Among the common illnesses caused by bacteria, are a large number of intestinal diseases. Aside from its role in gastro-intestinal infections, *E.coli* can also cause systemic infections and septicaemia. Staphylococcus is often involved in skin diseases. Poor hygiene can often cause neonatal dermatosis, neonatal conjunctivitis (with an accumulation of purulent discharge behind the eyelids), or umbilical infections in newborns.

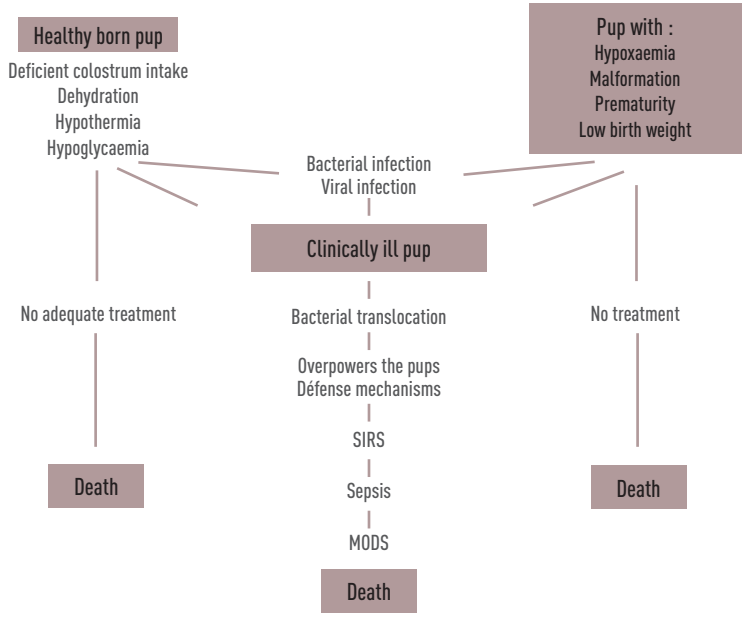
Sepsis develops if a bacterial infection overcomes the newborn's defence mechanisms intended to protect against infectious agents. Normally, the intestinal mucosa represents the first obstacle, preventing the bacteria from

accessing the tissues and systemic organs; However, in newborns, the intestinal epithelium appears to be more permeable to bacteria, and notably *E.coli.* Inflammation of the small intestine (or enteritis), initially without complication, can therefore causes sepsis much more easily in newborns than in adults.
Aside from the digestive system, the peritoneal cavity, the navel, airways, skin and skin injuries, and the urinary system are all channels through which bacteria can enter the blood stream.
Vertical infections seem to be the main route of infection by *E.coli* in newborns, directly from the intestinal flora of the mother or other animals in the breeding facility or even strains from the mother's vagina.

Canine herpes virus (CHV1) is the most serious viral infection for young puppies. Infection within the first 18 days generally leads to death of the entire litter, with the puppies dying one after another. The younger the puppies, the more fatal the disease.

Parasite infections alone rarely cause the death of a newborn, but associated with other causes, can often be a trigger.

Mechanisms responsible for neonatal mortality



• Herpesvirus infection

Herpesvirus infection is a viral disease of puppies during the first weeks of life provoked by canine herpesvirus type 1 (CHV-1). Herpesvirus is responsible for abortion in pregnant bitches and neonatal mortality in puppies. Usually infected puppies present lethargy, crying, diarrhea and respiratory syndromes around first week of age. Afterwords, a multiorgan failure is developed leading to death 24-48h after the first symptoms. However, sudden death without any clinical signs in puppies is also observed.

No treatment exist for herpesvirus infection, and therefore correct prophylaxis is crucial to decrease the risk of infection. Puppies can become infected already at the fetal life, as herpesvirus can pass the placental barrier. The infection may occur also during birth and first days of life due to the contact with maternal excretion, such as vaginal or oropharynx secretions. Contamination among infected littermates is also possible. In order to prevent canine herpersvirus infection bitches can be vaccinated during gestation (2 vaccinal injections: first one at mating and second one 10 days before whelping). Other important point to prevent the hespesvirus infection is the adequate temperature in the whelping box.

Scientific studies demonstrated that puppies kept in higher environmental temperature presented lesser clinical symptoms and lower mortality rate after the herpesvrius infection. Therefore, additional heat sources, ensuring environmental temperature at 28-30°C Celsius are crucial to prevent herpesvirus infection in puppies.

• Canine minute virus infection

Canine minute virus infection is caused by canine parvovirus type 1 (CPV1). In bitches infected during first half of gestation abortion may be observed. In bitches infected in second part of gestation, puppies may be born with anasarca or inflammation of heart (myocarditis). Following symptoms are observed in puppies infected by the minute virus: failure to nurse, diarrhea, constant crying, difficulty on breathing. Most often symptoms appear between 1 and 3 weeks of age, with either full recover observed within few days or sudden death. No treatment exists against canine minute infection. Bitches are infected via oro-nasal route, passing the virus to the offspring either during the pregnancy (transplacental transfer) or after birth. **The prevention of the disease consists of efficient hygiene protocol. No vaccination is available to prevent canine minute virus infection in puppies.**

• Canine and feline neonatal septicemia

Neonatal septicemia is a serious bloodstream infection in both puppies and kittens, usually caused by commensal bacteria (i.e., normally non pathogen bacteria colonizing the mucosal surfaces and skin).
Puppies or kittens with septicemia may present anorexia, hypothermia, crying, diarrhea, inactivity and sometimes necrosis of the lateral parts of the body (tip of ears, paws, tail). Often sudden death without any clinical symptoms is observed in septicemic newborns. Puppies and kittens are more susceptible to septicemia during the first week of life.
If the disease is early diagnosed, ill puppy or kitten can be treated via antibiotic therapy. Additional nursing and special care should be provided to the infected newborn, in order to ensure correct food intake and adequate body temperature. **Treatment of the entire litter should be considered.**

Canine and feline septicemia are most often caused by inadequate colostrum intake (and thus deficit of maternally derived antibodies and deficit of the energy intake) **or by inappropriate environmental conditions** (low temperature in the whelping box, low hygiene, etc.). In such conditions, the normal bacterial flora passing from the dam's mouth, skin, vagina and anus may become pathogenic for the highly susceptible newborn.

Neonatal septicemia can be avoided:

- thanks to assist nursing during the first hours after birth ensuring adequate colostrum intake (acquisition of the maternally derived antibodies)
- thanks to systematic weighing of the newborns ensuring correct energy intake (once or even twice per day)
- thanks to correct environmental temperature in the whelping box (about 28-30° at the puppy level)
- and high hygiene standards in the breeding kennel.

Feline viral rhinotracheitis: Herpesvirus (FHV-1)

Symptoms: incubation period of 1-4 days. Apathy, anorexia, nasal and auricular discharge and moderate conjunctivitis may be observed in infected kittens. If the eyes are not yet open (<1 week old), the pus accumulates behind the eyelid: neonatal ophthalmia. If immunity transfer is insufficient, the infection can affect the bronchi. A secondary bacterial infection can also occur, causing pneumonia, resulting in death of the newborn. The mortality rate is high.

Treatment: symptomatic treatment may be implemented by the vet and good hygiene of the eyes and nose is important, associated with tube feeding.
However, it must be remembered that clinical cure does not imply definitive elimination of the virus by the body. More than 80% of cured kittens remain carriers of the latent virus.
Transmission mode: the virus has a low level of resistance in the environment but is highly contagious, and transmission is by air. The virus presents the particularity of going into latency (like in humans) and reappearing during periods of stress, for example, during birthing, resulting in a higher risk of transmission. Unlike in dogs, infection during gestation does not appear to terminate the pregnancy.

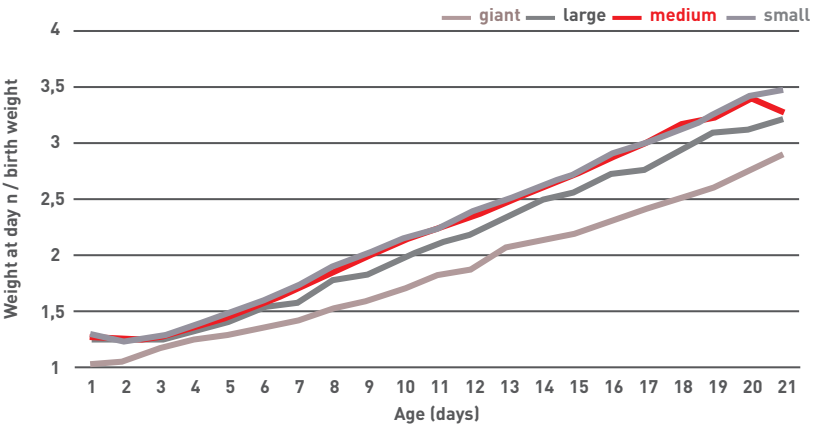
PREVENTION METHODS
- Prevention by annual, synchronised vaccination of all reproducers.
- Vaccination of females before birthing (reducing exposure of kittens and boosting the passive transfer against this virus).
- Expectant mothers can be given lysine to limit recurrence and therefore excretion during birthing.

7.3. EARLY GROWTH: A VITAL INDICATOR OF HEALTH

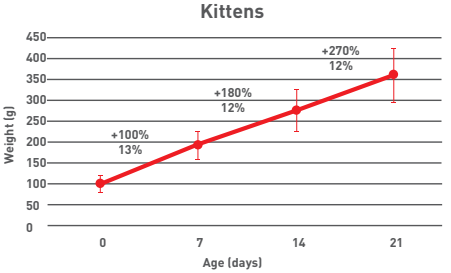
7.3.1. EVOLUTION OF WEIGHT GAIN DURING THE FIRST 21 DAYS

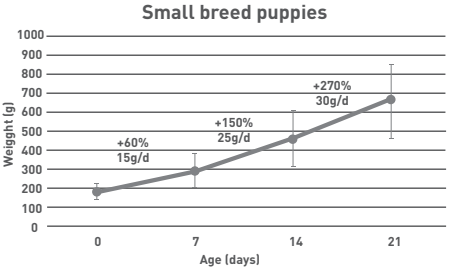
Weight should be recorded carefully with a gram scale at birth, after 12 hours of life, and then once per day during the first two weeks, but in any case of sickness every second hour. Depending on the size of the breed, the growth curves differ for the first few weeks. If the puppy's weight is plotted against its birth weight, weight doubles between 9 and 13 days and is multiplied by four between 25 and 30 days, depending on the breed size. **A slower rate of growth is observed in large or giant breeds, compared with medium or small breeds.**

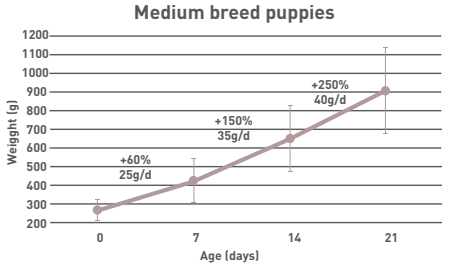
Puppy growth over the first 21 days of life (Belin, 2013)

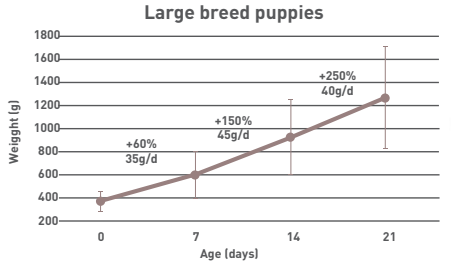


Growth during the first three weeks of life









7.4. SUBSTITUTE MILK

7.4.1. WHEN TO USE A SUBSTITUTE MILK

The mother's milk is the ideal food for puppies and kittens up to the age of 3-4 weeks. **It provides all the nutrients necessary for their development,** as well as antibodies to protect them against common diseases. **The mother's milk therefore gives puppies and kittens the best chances in terms of growth, development and health. It is therefore recommended to encourage maternal feeding whenever possible.**

The mother's milk is the ideal food for puppies and kittens up to the age of 3-4 weeks.

However, **there are certain specific circumstances in which industrial substitute milk must be used.** This is the case if the newborns are **orphaned,** if there are **too many in the litter,** or **if the mother's milk is not suitable for consumption** (mammary gland condition: mastitis, toxic milk syndrome). Similarly, if **the puppies or kittens fail to gain weight for two consecutive days** and no pathological disorder is detected, it is possible that the mother's milk production is insufficient and the newborns are not getting enough milk to ensure their growth. In this case, supplements given in the form of bottles of substitute milk can be a useful option to wean the entire litter. **It is recommended that artificial supplements are provided to the entire litter rather than removing one or more individuals to feed them exclusively with formula milk.** In cats, if there is a risk of isoerythrolysis following a risky mating (see specific section), the kittens must not ingest their mother's milk during the first 24-48 hours of life. During these first two days, substitute milk must be used.

7.4.2. HOW TO CHOOSE THE SUBSTITUTE MILK

The substitute milk must **be as close as possible to the dog or cat's milk.** A number of points must be taken into account when choosing a substitute milk.

7.4.2.1 AVOID USING COW OR GOAT'S MILK

Dog and cat's milks are roughly twice as dense in energy, protein and fat than cow and goat's milks, which contain more lactose. **The use of cow or goat's milk to feed dogs and cats can therefore cause delayed growth** (due to the lower energy concentration) and diarrhoea (due to higher lactose content). It is therefore recommended **to use industrial formula milks, specially designed to meet the needs of puppies and kittens.** However, it will be **important to check that there is enough fat in the milk chosen.** An American study of 15 industrial puppy formula milks reported that almost half of the milks had a lower fat content than natural dog's milk.

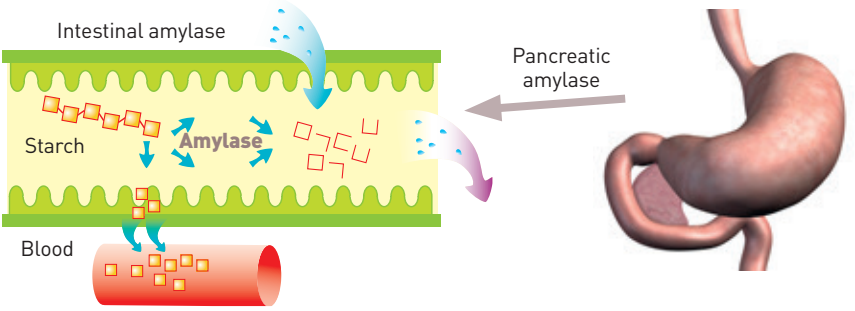
Comparative analysis of dog, cat, cow and goat's milks

	Dog	Cat	Cow	Goat
Energy (Kcal/100g)	146	120	67	70
Protein (%)	7,5	7,5	3,3	2,9
Fat (%)	9,5	8,5	3,3	3,8
Lactose (%)	3,3	4	4,7	4,4

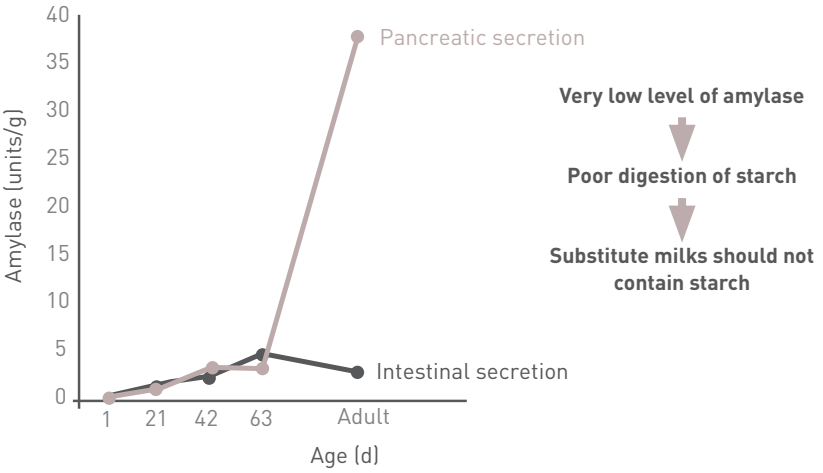
7.4.2.2 USE MILK THAT CONTAINS NO STARCH

Adult cats and dogs digest starch thanks to a specific enzyme called amylase. This enzyme, secreted by the pancreas and intestinal villi, breaks the starch down into smaller carbohydrates, which can be absorbed into the blood.
In puppies and kittens, the pancreatic and intestinal amylases are not fully developed, making it impossible to digest starch. **It is therefore important to use a milk that contains no starch to avoid possible diarrhoea disorders.**

Starch digestion in adult dogs



Enzyme creation (amylase) of the puppy from birth to adulthood, according to



7.4.2.3 LACTOSE SHOULD BE THE MAIN CARBOHYDRATE IN THE MILK

Lactose is the main carbohydrate in dog and cat's milk. However, its concentration is roughly 30% less than that of cow's milk. The lactose in the mother's milk is particularly beneficial. It is a disaccharide (two combined sugars, one glucose molecule, associated with a galactose molecule), easily digested by the newborns by specific digestive enzymes (lactases). **The substitute milk should therefore contain mostly lactose.**

Particular attention should be paid to the lactose and mineral concentrations in the substitute milk. The levels of these nutrients affect the **osmolarity of the milk.** If osmolarity is too high compared with dog or cat's milk (average osmolarity 333 mOsm/L) the milk may cause vomiting (due to delayed gastric emptying) and diarrhoea (by water intake into the digestive tract). The consequences for the animal can be serious (risk of liquid passing into the lungs in the case of vomiting or dehydration in the case of diarrhoea).

7.4.2.4 BENEFIT OF DHA IN FORMULA MILKS

Docosahexaenoic acid (DHA) is an important nutrient for neurological development in both humans and animals. DHA can come from direct ingestion of this nutrient or ingestion and transformation of its precursor, alpha linolenic acid (ALA). Direct intake of DHA is, however, more efficient to ensure the neurological development of puppies. In very young puppies and kittens, this DHA comes solely from the maternal or substitute milk. When using a substitute milk, it is therefore very **important that this milk contains DHA.** And yet, this is far from being systematic. An American study of 15 puppy formula milks reported that only 3 of the 15 milks contained detectable levels of DHA and only one milk had a higher level of DHA than that found in natural dog's milk.

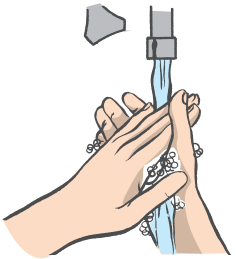
7.4.2.5 SUPPLEMENTATION OF FORMULA MILKS WITH MALTODEXTRIN

In human medicine, some industrial formula milks are specially formulated for premature babies with a low birth weight. Part of the lactose in such milks is replaced by another carbohydrate: **maltodextrin,** to optimise digestion by these children at risk. Some puppy milks now contain this sugar. A recent study showed that supplementation of puppies at risk due to low growth rate (puppies loosing over 4% of weight during the first days of life) every 6 hours during the first two days of life with this type of milk (Baby dog milk®, Royal Canin enriched with maltodextrin) **ensured better growth** (fewer puppies at risk of mortality, i.e. fewer puppies with a weight loss greater than 4%) **and enabled body temperature to be maintained.**

7.4.3. PREPARATION PRECAUTIONS

How the bottle is given is as important as the quality of milk in it. Newborns are fragile and must be protected by meticulous hygiene of the feeding systems used. The person preparing the milk and giving the bottles must therefore wash his/her hands before making up the bottles. Before being filled with milk, the bottles must be washed thoroughly (with a bottle brush) and rinsed with very hot water.

7.4.3.1 HOW TO CLEAN A BOTTLE



STEP 1
Wash your hands with soap and water and dry using a clean cloth.

STEP 2
Wash all feeding and preparation equipment thoroughly in hot soapy water. Use a clean bottle and teat brush to scrub the inside and outside of bottles and teats to make sure that all remaining feed is removed from the hard-to-reach places.

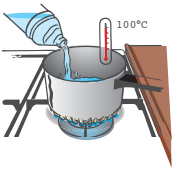
STEP 3
Rinse thoroughly in clean water.

7.4.3.2 PREPARING THE MILK

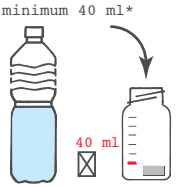
The milk must be prepared immediately before being given. A bottle that has been started should be discarded. Prepared, stored bottles offer ideal conditions for bacteria to develop, particularly if kept at room temperature. Similarly, a tin or sachet of milk that has been opened must not be kept for more than one month, and preferably kept in the fridge.
Unless otherwise indicated by the manufacturer, the milk should be prepared with hot water so that after mixing in the powder, the milk temperature is around 35°C when given to the newborn. **The puppy should be allowed to suckle as long as it wants on each bottle.**

CAUTION: do not use a microwave oven to prepare or reheat bottles. Microwave ovens do not heat evenly and some parts of the bottle may be too hot and burn the puppy or kitten. Reheating a colostral supplement containing immunoglobulins (antibodies) in the microwave results in the destruction of these specific proteins thus eliminating the beneficial effects of these supplements.

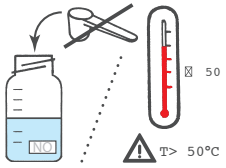
MILK PREPARATION



Manage water temperature

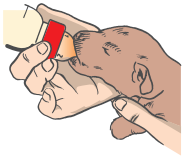


Use low sodium mineral water.



FEEDING OF THE MILK

Milk must be at a temperature of around 35°C



Only use undamaged teats

Use the milk within one hour and throw away the remainder

AFTER MEAL CARE

Stimulate the perineum area

7.4.3.3 HOW TO GIVE A MILK SUBSTITUTE

After reconstitution, the milk is given either via a bottle, or using a flexible feeding tube if the newborn refuses to suckle. For newborns suckling properly, bottle feeding is the safest way. The suckling reflex is necessary for bottle feeding; **do not force a puppy or kitten to suckle** or it may ingest into the bronchial system, resulting in milk in the lungs. This accident can cause immediate asphyxia (drowning) or pneumonia may develop later, endangering the life of the newborn. **Do not feed puppies or kittens on their backs** like when feeding babies: they must be in the prone position to prevent the milk from going down the wrong way. Similarly, the **size of the teat and its opening should be adapted to the size of the puppy** in order to avoid the risk of milk going down the wrong way.

If the suckling reflex is insufficient or absent, the colostral substitute must be administered directly to the stomach via a feeding tube. **Intubation is a technical process, because the tube must not be passed into the lungs. If you intend to use this technique, it is essential to ask your vet for advice and a demonstration.**

Newborns that are too weak to suckle can be intubated to ensure efficient feeding.

Advantages and disadvantages of the different methods of administering formula milk

Technique	Advantages	Disadvantages
Bottle	The puppy suckles at will	Takes a long time (not suitable for large litters → intubation)
		Requires the suckling reflex
	Equipment easily available	Ingestion into bronchial system is possible
Feeding tube	Quick (useful for large litters)	Suitable equipment required
	Suitable if no suckling reflex	Risk of ingestion into bronchial system
	Suitable for cases of cleft palate	Risk of problems due to overfilling of the stomach
		Technique to be learned

7.4.3.4 FEEDING FREQUENCY

Puppies will suckle spontaneously more than twenty times per day, so it is difficult for a breeder to maintain this rate of feeding. **Ideally, puppies should be fed every three hours for the first week, adopting a regular rhythm and always respecting the sleeping periods** (more than 90% of the time during the first week), essential to the attachment and bonding phenomena.

FREQUENCY OF SUBSTITUTE FEEDING IN ORPHAN PUPPIES/KITTENS

- 1st week: 8 meals/day
- 2nd week: 5 meals/day
- 3rd week: 4 meals/day
- 4th week until weaning: 4 meals/day

THE GOLDEN RULES OF FORMULA FEEDING

- If possible, resolve the reason behind the need for formula feeding
- Choose a formula milk specially designed for puppies/kittens
- Bottled water is preferable for making up the milk
- Prepare the milk immediately before feeding
- Give the milk at a temperature of around 35°C
- Do not keep prepared milk for more than one hour
- Bottle feeding is preferable to tube feeding
- Take care of the puppy if it is an orphan (stimulation of the perineum area to stimulate defecation and urination)

7.4.3.5 WHAT TO DO AFTER FEEDING THE PUPPY OR KITTEN

Once the puppy or kitten has had its formula milk, it is important to stimulate the perineum region with cotton wool soaked in warm water to stimulate defecation and urination. This is particularly important in orphaned animals. They do not have the neurological maturity to urinate and defecate spontaneously; since the mother is not available to lick the newborn, it will be totally dependent on stimulation after the feed. Failure to do this exposes the newborn to the risk of constipation.

MORE INFORMATION

- *Heinze CR, Freeman LM, Martin CR, et al. Comparison of the nutrient composition of commercial dog milk replacers with that of dog milk. J Am Vet Med Assoc 2014;244:1413-1422.*
- *Debraekeleer J. Comparative analysis of milk replacers for puppies and kittens. Journal of Animal Physiology and Animal Nutrition 1998;80:185-193.*

8 CONCLUSION

8.1. THE MAIN CAUSES OF NEONATAL MORTALITY IN PUPPIES

Gestation

- Nutrition
- Drugs
- Environment
- Infectious disease

Birthing

- Dystocia
- Nutrition
- Maternal behaviour
- Management by breeder

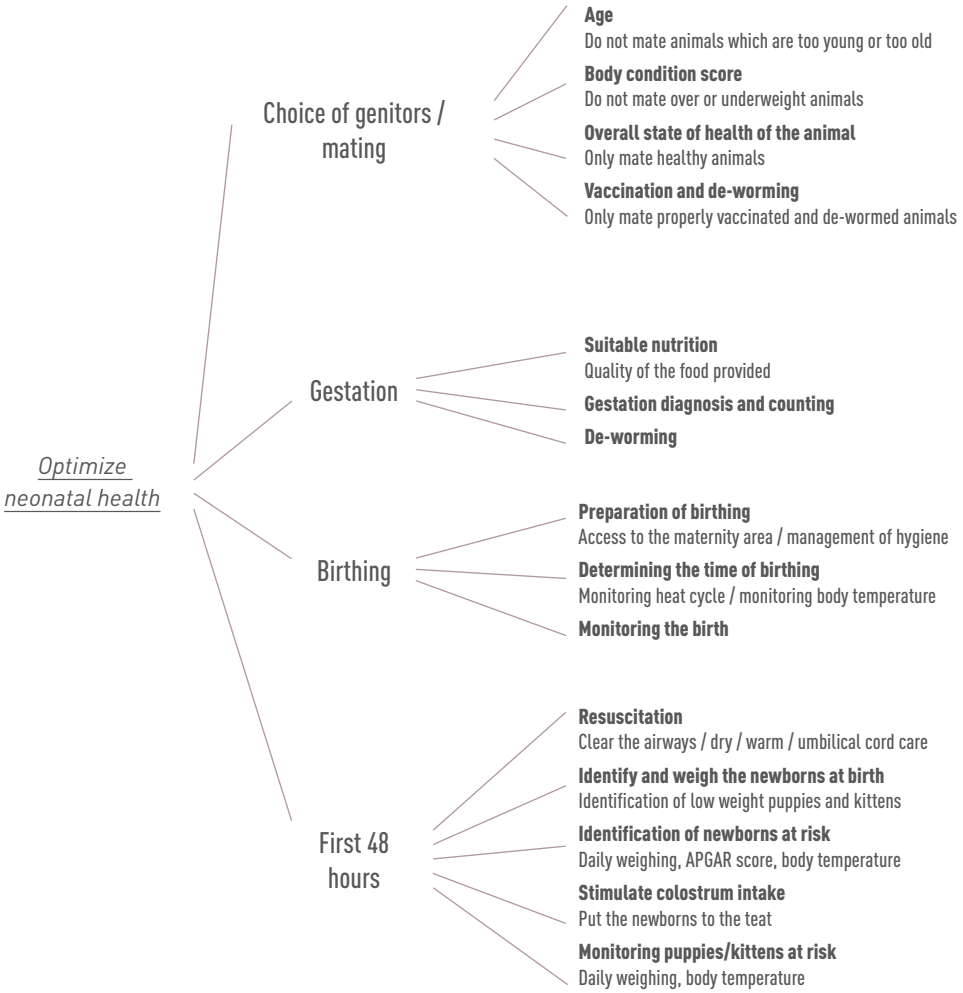
0-2 days

- Congenital anomalies
- Colostrum intake
- Maternal behaviour
- Environment

2-21 days

- Milk intake
- Environment
- Infectious disease

8.2. HOW TO OPTIMISE NEONATAL HEALTH



ROYAL CANIN®