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Canine neonatal mortality in four large breeds

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Introduction

The canine neonatal period refers to the first 2–3 weeks of life. The rate of stillbirth and neonatal death is known to be relatively high in dogs. The few studies that has been published indicate a mortality of 17–30% within the first 8 weeks of life [1-6]. Stillbirth and death within the first week post partum was responsible for the majority of the puppy losses in these studies.

The high mortality in canine neonates are related to many factors, including prolonged labour, maternal neglect or carelessness, lack of milk, plus congenital abnormalities and acquired disorders in the neonate [1,3-5]. The immature status of the newborn puppies makes them vulnerable and totally depending on intensive care from the dam. The puppies are highly susceptible to hypothermia, due to poorly developed thermoregulatory mechanisms. They cannot induce peripheral vasoconstriction or react to low temperature by shivering. The energy requirement is high, but the energy reserves are low and the immature liver is inefficient in generating energy. This makes the neonate predisposed to hypoglycaemia. Due to immature kidney function there is an increased risk of dehydration. The neonates have a high percentage of body water (82%) compared to adults and have a greater loss of water through their lungs and skin due to a large surface to volume ratio, which further increase the risk of dehydration [7-9].

Data of incidence and risk factors for mortality are important to acquire, in order to prevent the neonates from dying. The objectives of the present study are to report prevalence rates and risk factors concerning stillbirth and neonatal mortality in four large dog breeds.

Materials and methods

The study was conducted as a prospective, longitudinal, observational study and includes all puppies from 98 litters of Irish wolfhound (n = 16), Leonberger (n = 30), Labrador retriever (n = 21) and Newfoundland (n = 31). Participation in the study was available to all Norwegian breeders with litters born from November 1998 to June 2001. The study is a part of a larger ongoing research project [10]. Inclusion of a litter started when the dam was mated. The breeder signed a written agreement to follow the project plan. The parent project included 107 litters, which is 23.2% of the total number of litters born in these breeds in Norway during the period. Nine litters were excluded from the present study because they entered the study >3 weeks old.

All data concerning history, management and clinical information are obtained from the breeders, who answered to questionnaires in a booklet prepared by the project leaders. The recorded data included vaccination and deworming status of the dam, problems during pregnancy, birth and lactation, number and gender of born puppies as well as hours from the birth of the first to the last puppy, which in this study is reported as the duration of the parturition. The breeders also completed questions concerning any diseases and deaths of puppies from birth until they were delivered to the new owner at approxi-

mately 8 weeks of age. The body weight of each puppy was recorded by the breeder at birth, when the puppy was 3 and 7 days old, and then once a week until 8 weeks of age.

Data were analysed with Microsoft Excel statistical software, and presented as means ($\bar{x}$) and standard deviation (SD). A two-tailed student t-test was used to determine if the means were significantly different. The mortality rates are presented as percent.

Results

A total number of 744 puppies were born (362 males, 366 females; 16 of unknown gender), giving a mean litter size of 7.6 puppies. An average of 0.8 puppies per litter (10.9%) were stillborn (n = 81, 38 males, 27 females, 16 unknown gender). There were no reports of any mummified foetuses. During the first 3 weeks of life, the mortality rate of live born puppies was 6.9% (n = 45; 23 males and 22 females), of which the majority (64%) died within the first 3 days. The mean litter size at 3 weeks was 6.3. Table 1 shows the mean number of dead puppies per litter and mortality rates the first 3 weeks post partum. Only five puppies died or were euthanized during the following 5 weeks of life.

The number of stillborn puppies per litter in relation to litter size and to the duration of birth is given in Table 2. The mean size of litters with no stillborn puppies was 6.9 (±2.9), compared to 10.3 (±3.9) in litters with >3 stillborn puppies (n = 4). These four litters had a total of 41 puppies, of which 25 were stillborn. The mean size of litters with ≥1 stillborn puppies was 8.9 (±2.4), which was significantly different from litters with no stillborn puppies ($p < 0.001$). The time from birth of the first to the last puppy in litters with ≥1 stillborn puppies occupied 13.8 (±8.6) hours, which was significantly different from litters without stillborn puppies (7.0 ± 4.2 hours) ($p < 0.001$). The length of parturition was only given for 84 litters; the majority of the missing litters were delivered by caesarean section.

One litter had 15 puppies, of which 10 were stillborn. The litter was born over a period of 40 hours. Another dam had 6 live and 6 stillborn puppies; 24 hours after the first puppy was born 2 dead puppies were delivered by caesarean section. Three dams had one foetus that was born or surgically removed more than 24 hours after the parturition was believed to be completed. In these cases, the duration of birth was calculated as the time from the first to the last puppy delivered per vaginam when the breeder believed the birth to be completed. One puppy was removed by hysterectomy 15 days after the dam gave birth to 7 live puppies in 7 hours. The dam died two hours after the operation. Another dam delivered 12 puppies in 13 hours. The two last were stillborn, and another stillborn puppy was delivered by caesarean section 26 hours later. One dam gave birth to 5 live and 3 stillborn puppies in 16 hours, and delivered another stillborn puppy 8 days later. The breeder described that the dam had been rather listless for some days, but recovered after the delivery of the last puppy and treatment with antibiotics.

The mean body weight at birth of the puppies that died during the first week was significantly lower than the birth weight of those who were alive at 8 weeks (Table 3) ($p = 0.005$). Compared to the mean body weight at birth, the mean weight at 3 days had increased 24%, at 7 days the weight increase was 83%, and at 14 days the weight had increased 189%.

Mortality causes are shown in Table 4. The most frequent cause of death the first 3 days of life was low birth weight (less than 50% of the siblings) (n = 7). Six puppies from one litter, of which two were autopsied, died from starvation due to agalactia. Another puppy was euthanized at birth due to omphalocele, an abdominal wall defect resulting in viscera misplaced outside the abdomen. Only two puppies in this litter survived. Nine puppies that died before two weeks of age, had signs consistent with the fading puppy syndrome: unusual restlessness with persistent crying, forced respiration, poor sucking response and generalized weakness. Four puppies were born with omphalocele. Two were operated, of which one died 2 days old,

Table 1: Loss of puppies from birth until 21 days of age in four breeds with a total of 98 litters (l) and 744 born puppies (n): Irish wolfhound (l = 16, n = 121), Leonberger (l = 30, n = 254), Labrador retriever (l = 21, n = 173) and Newfoundland (l = 31, n = 196).

Age at death	Dead puppies n	Dead puppies per litter $\bar{x}$	Mortality %	Mortality of live born puppies %
Stillborn	81	0.82	10.9	
0–3 days	29	0.30	3.8	4.4
4–7 days	9	0.09	1.2	1.3
8–14 days	6	0.06	0.8	0.9
15–21 days	2	0.02	0.2	0.3
Sum	127	1.29	16.9	6.9

Table 2: Number of stillborn puppies per litter in relation to litter size and duration of parturition (hours from birth of the first to the last puppy).

No. stillborn puppies per litter	Litter size			Duration of parturition (hours)		
	n of litters	$\bar{x}$	SD	n of litters	$\bar{x}$	SD
0	65	6.9	2.9	55	7.0	4.2
1	12	8.7	1.9	10	10.6	4.2
2	8	8.4	2.5	7	9.1	2.6
3	9	9.1	2.4	9	18.2	7.8
>3	4	10.3	3.9	3	22.7	6.6
Sum/mean	98	7.6	2.9	84	9.5	6.9

the other died at the age of 10 days. Four puppies died within 1 hour after birth, of which two were delivered by caesarean section and two after prolonged labour. Seven puppies from 6 litters died of trauma caused by the mother.

Discussion

The major cause of reduced litter size were stillborn puppies, as 10.9% of the puppies were stillborn, reducing the average litter size with 0.8 puppies. This incidence of stillbirth is higher than reported in other studies. Bowden *et al*. [2] reported 7% stillborn puppies in a study of 541 litters of 111 breeds, and in a study of 413 Boxer litters 5.5% of the puppies were stillborn [4,6]. The high incidence of stillbirth in our study may be due to more complete registrations of stillbirths, as the breeders prior to birth of the litter had signed a contract to record the information in a prospective study. Another factor was most probably that the average litter size was higher in our study (7.6) compared to these other studies: 5.7 [5] and 6.4 [4,6], respectively. Our study showed a significant relationship between litter size and stillbirth; the average litter size was significantly higher in litters with stillborn puppies (8.9) compared to litters in which all puppies were born alive (6.9).

In 2/3 of the litters there were no stillborn puppies. Nearly 1/3 (31%) of all the stillborn puppies were found in 4 litters. Ten of these puppies were from one single litter, which is 12% of all the stillborn puppies in the study. This might indicate that in a larger study, like the studies of Bowden *et al*. [2] and Nielen *et al*. [4,6], the rate of stillbirth will be lower, as a small number of litters with a catastrophic high rate of stillbirths will have less influence on the prevalence of stillbirth in the population.

It is reasonable to believe that most of the stillborn puppies in our study could have been saved with adequate veterinary assistance. In the litter where 10 out of 15 puppies were stillborn, the birth lasted for 40 hours. Despite the fact that most of the puppies were delivered by extraction and repeated injections of oxytocin, no caesarean section was performed. Another dam which received numerous injections of oxytocin, gave birth to 10 puppies, of which four were stillborn. The remaining two puppies, both dead, were removed by caesarean section 24 hours after the birth of the first puppy. Normally a birth should be completed within 12 hours. In some cases in large litters it might be acceptable that the birth continues up to 24 hours, on the assumption of sufficient uterine contractions and normal progress of the birth. Secondary inertia due to exhaustion is not uncommon in large litters.

Table 3: Mean birth weight of puppies that died during the 7 days of life and of puppies that were alive at 8 weeks.

Gender	Puppies dead 0–7 days			Puppies alive at 8 weeks		
		Birth weight (grams)			Birth weight (grams)	
	n	$\bar{x}$	SD	n	$\bar{x}$	SD
Male	12	408	156	268	527	137
Female	13	404	186	274	498	123
Both genders	25	406	167	542	512	130

Table 4: Causes of mortality in 46 puppies that died before 3 weeks of age, recorded by the breeder, from a population of 663 live born puppies of four breeds (Irish wolfhound, Leonberger, Labrador retriever and Newfoundland).

	Age in days at death			
	0–3	**4–7**	**8–14**	**15–21**
Dead < 1 hour	4	-	-	-
Diarrhoea	1	-	-	-
"Fading puppy syndrome"	3	5	1	-
Convulsions	1	-	-	-
Trauma*	3	3	1	-
Heart problem	-	-	-	1
Starvation	6	-	-	-
Omphalocele	3	-	1	
Cleft palate	1	-	-	-
Low birth weight**	7	-	-	-
No cause given	-	1	3	1
Sum	29	9	6	2

* Smothered by the mother
** Birth weight less than 50% of the siblings

Injection of calsium borogluconate (14 mg Ca/ml, 1–3 ml/10 kg iv or 2–4 ml/10 kg sc) and glucose (50 mg/ml, 3–6 ml/10 kg iv or 5–10 ml/10 kg sc) may be given to support uterine contractions, if necessary supported by a low dose of oxytocin [11]. If the contractions still are poor and there are several unborn puppies, it would be advisable to perform a caesarean section. Very large litters may result in primary uterine intertia, due to overstretching of the uterus preventing uterine contractions [12]. When primary inertia is diagnosed in bitches with large litters, the treatment should be caesarean section. Primary uterine inertia was probably the reason why five puppies died in a litter of seven were caesarean section was performed too late to save the majority of the puppies.

The puppy loss during the first 3 weeks of life was 6.9% in our study. During the next 5 weeks another five puppies died or were euthanatized; the puppy loss from birth to 8 weeks was 7.5%. This is less than reported in other studies. In the study of Bowden *et al*. [2], the mortality of live born puppies from 0–3 weeks was 23.9% (not including stillbirth or puppies destroyed at birth due to deformities, weaklings, lain on by the bitch or euthanized due to wrong colour), and Hopper [3] found that 15% of the puppies that were born alive, died during the first week. In the Boxer study of van der Beek *et al*. [6] 12.4% of the live born puppies died before 7 weeks of age; another 3.9% were euthanatized due to white colour. One important reason for the lower preweaning mortality in our study might be the very low prevalence of infectious diseases. Herpes virus infections are rare in Norway, and there were no reports of herpes virus infections in this study. All the dams in the study had recent and valid vaccination against parvo, distemper and hepatitis viruses.

Very little or no milk production the first couple of days was reported in four litters. Six puppies from one litter died due to starvation. Two of the puppies were autopsied, and the breeder managed to save the last two puppies with milk supplement. In two other litters with very low milk production, four puppies with minimum weight gain and symptoms consistent with fading puppy syndrome, died within the first week. It is important to advice breeders to record the body weight daily the first week to ensure normal weight gain. It is not uncommon for a puppy to loose up to 5% of its body weight the first day, but it must gain weight during the next couple of days to survive. In this study the puppies that were alive at 8 weeks had an average daily weight gain of 8% the first three days and 12% during the next four days, compared to the birth weight. This is more weight gain than found in other studies [13], but is probably due to the fact that our population consists of large breeds that have a relatively low birth weight and more rapid growth compared to smaller breeds.

Colostrum is vital for passive transfer of immunity to the newborn puppy. Although dogs have an endotheliochorial placenta where endothelium of the uterine vessels is the only structure separating the maternal blood from the chorion, only small amounts (5–10%) of the total immunoglobulins provided by the dam are transferred to the foetus through placenta [14-16]. Colostrum represents the accumulated secretion of the mammary gland during the last third of pregnancy, and immunoglobulins secreted in colostrum are readily absorbed in the blood from the upper part of the small intestine few hours after birth. Intestinal absorption of immunoglobulins is minimal after 12 hours [17]. If the dam has poor or no milk

production when the puppies are born or if the puppies are too weak to suckle, they should be given serum, preferably from the mother. The study of Bouchard *et al*. [17] showed that administration of 8–16 ml pooled serum sc at birth, or orally at birth and 12 hours post partum, provided similar effect as colostrum. If the puppies are too weak to suckle, they should receive an injection of 5% glucose sc to prevent hypoglycaemia [11].

A puppy that is apparently normal at birth but fails to survive beyond 2 weeks of age is often referred to as a fader. The aetiology for this fading puppy syndrome includes a whole range of causes, like poor mothering, inadequate nutrition, inadequate colostrum, trauma and congenital anomalies, low birth weight and infections [7,18]. The clinical signs of many neonatal diseases are very similar and vague, like restlessness, crying, low body temperature, diarrhoea and breathing difficulties. In absence of a more specific diagnose the term fading puppy syndrome is often used. Because of the immature status of the newborn puppy, a sick neonate may rapidly become hypothermic, hypoglycaemic, dehydrated and hypoxic and then die – regardless of the initiating insult [8]. In our study, nine puppies died during the first 2 weeks of life due to the vague signs typical for the fading puppy syndrome, or maybe a better term would be "sick puppy syndrome". Four of these puppies had received inadequate colostrum due to the mothers' very poor milk production the first couple of days and had received no serum at birth to compensate for the missing colostrum.

Seven puppies, from 0–2 weeks of age were killed due to trauma caused by carelessness of the mother. The breeds in this study are large breeds, and the weight of the newborn puppy in these breeds is about 1% of adult weight. Even a small incautiousness of the mother can result in lethal trauma to the puppy. To prevent this, the dam should be looked after by the breeder when she is nursing and feeding her puppies until the puppies are 2 weeks old.

Conclusion

A rather low number of litters made a large contribution to the rate of stillbirth and mortality the first weeks of life in this study. Information and education both of breeders and veterinarians will probably play a major role in reducing the rate of stillbirth and neonatal deaths. Dams with large litters and insufficient uterine contractions should be released by a caesarean section if a couple of injections of oxytocin, calsium and glucose are not sufficient for the dam to deliver the remaining puppies. Several oxytocin injections to a dam with many unborn puppies result in poor prognosis for the remaining puppies, great distress for the dam and can put at risk the life of both the dam and puppies already born. This is not consistent with appropriate animal welfare and should therefore be considered unethical.

The weight of the puppies should be recorded daily the first week to ensure sufficient weight gain. If puppies are not fed colostrum, due to poor suckling reflex or agalactia of the dam, they should be supplied with serum from the dam. Dams of large breeds should be looked after when they are together with the puppies the first 2 weeks.

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