Diagnosis of canine and feline neonatal death: A retrospective study of 107 cases (2000-2010)

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Abstract

The objective of the study was to characterize common causes of canine neonate death by evaluating diagnostic records and thus provide information to practitioners regarding potential preventative options. A total of 107 canine and feline neonates ranging from 0 to 7 days of age submitted to Washington State Animal Disease Diagnostic Laboratory (WADDL) during the years 2000-2010 were evaluated. Gross examination of all tissues and body cavities; as well as collection of representative samples for bacteriology, virology and histopathology was performed. A diagnosis was made 72% of the time when a dead neonate was submitted to WADDL. An infectious cause was responsible in 41% of submissions, and 37% had a non-infectious cause of death. The most common cause of death of the cases submitted to WADDL over the ten year period was septicemia accounting for 15% of the diagnoses. This was closely followed by aspiration pneumonia, which accounted for 14% of the diagnoses. The information gained from the study gives insight on the most common causes of neonatal deaths and facilitates the understanding of how to prevent neonatal deaths in small animal populations.

Keywords: Neonate, septicemia, aspiration pneumonia, diagnosis

Introduction

Puppies and kittens at birth are blind, poikilothermic, and have limited mobility. Due to their immature status, neonates have complete reliance on their mother for life outside the womb and are highly susceptible to the environment. A recent comprehensive retrospective study[1] of 10,810 litters of 224 breeds registered in the Norwegian Kennel Club in 2006 and 2007 shows perinatal mortality in 24.6% of the litters. Eight percent of the puppies died before eight days after birth, with 4.3% as stillbirth and 3.7% as early neonatal mortality. Prematurity of the neonate is a significant cause of death in the young. There are many vital anatomical and physiological changes that take place during late gestation and after birth of a puppy or kitten. The first respiration is stimulated by hypoxia, hypercapnia, and cooling of the skin immediately after delivery and it must be taken within the first eight to ten minutes of life to prevent permanent brain damage or death.[2] The secretion of surfactant in the lungs is the last thing to develop in the gestation of the neonate and with prematurity, surfactant production is deficient and pulmonary function is hindered. Low birth weight is often accompanied by immature physiologic processes and inadequate production and release of lung surfactant and has been correlated with increased neonatal deaths.[3] Prematurity also results in an overall weak puppy or kitten and predisposes them to aspiration pneumonia, which leads to death in most cases.[1]

Neonates are unable to regulate their own body temperature so it is important that they be in a warm environment. The normal body temperature of a neonate is above 36.1°C. Hypothermia is reported to cause bradycardia, cardiovascular failure, neuronal injury, and ileus.[2] When the body temperature drops below 35°C, the neonate has trouble with oxygenation, which leads to hypoxia and stasis of the gastrointestinal tract. This stasis further exacerbates the risk for aspiration pneumonia, which often results in death of the neonate.

There are several infectious agents that are known risks to the lives of neonatal puppies and kittens. These include feline panleukopenia virus, canine parvovirus, canine and feline herpes virus, and a number of bacterial organisms. Fading puppy and fading kitten syndrome was not considered a cause of death in this study. Fading puppy or kitten syndrome is a name given to describe a combination of several clinical signs, which can lead to neonatal deaths but is not specific for one disease entity.[4]

In this study, necropsy records of canine and feline neonates age 0 to 7 days submitted to WADDL over a ten year period between 2000 and 2010 were reviewed. The information gained from the postmortem examination of these neonates was analyzed to establish the most common causes of neonatal

deaths in order to better understand how to prevent and control the rate of neonatal deaths in small animal populations.

Materials and methods

Whole carcasses of the deceased neonates were submitted to WADDL for necropsy from pet owners and private veterinary practitioners. Upon receipt of the carcasses at WADDL, a thorough necropsy was performed following typical postmortem examination protocol.[5] Gross examination was performed on all tissues and body cavities including the brain and representative samples of tissues were collected for histopathology. The gastrointestinal tract was evaluated in its entirety for amount and character of ingesta. At every necropsy, sterile samples of lung, liver, kidney, and spleen were collected for microbiologic testing. If abnormalities were found in other tissues on gross or histopathologic examination, those tissues were also collected for microbiologic testing.

Diagnostic laboratory records on all canine and feline neonates between the ages of zero and seven days submitted to WADDL from the years 2000 to 2010 were evaluated. A total of 107 cases were collected.

The information was analyzed and put into a spreadsheet for organization and analysis. Information was categorized regarding the answers to the following questions: Was an infectious agent responsible for the death? Could a cause of death be determined? From those not determined, was a complete analysis completed including bacteriology and virology? From this information a table was formulated of the most common diagnoses as well as the most common reasons for failure to obtain a diagnosis.

Results

From the data collected, there is a 72% (77/107) chance of obtaining a definitive or strongly suspected diagnosis regarding cause of death when a neonatal cadaver is submitted to WADDL for diagnosis. The most common cause of death in this study was septicemia and accounted for 15.8% (17/107) of the deaths. Of the neonates who died of septicemia, six originated from omphalitis and one from esophageal perforation. The source of septicemia was not identified in the remaining cases. Aspiration pneumonia accounted for 15% (16/107) of deaths in this study and was the second most common cause. Six neonates in this study (5% or 6/107) died of congenital abnormalities including ventricular septal defect, cleft palate, spina bifida, other congenital heart defects and atresia jejuni (table). The other known causes of death were less frequent and a complete list can be found in the table.

In 30/107 cases (28%), a definitive cause of death was not established. Some main reasons for not obtaining a diagnosis include the absence of an identifiable lesion, poor tissue quality, and the need for further workup. Possible factors which were not confirmed, but that may have contributed to the death of the neonates include hypoglycemia, hypothermia, environmental causes, metabolic derangement, in-utero stress, premature or complications during cesarean section anesthesia, suffocation, freezing/thawing tissue artifact and congenital cardiac arrhythmias. Other causes related to poor tissue samples include autolysis, excessive postmortem bacterial growth and method of euthanasia. In some cases, bacterial and/or viral cultures were not performed based upon client interest, and thus the presence or absence of organisms that could have been responsible for the death of the neonate was not confirmed.

Discussion

In this study, an infectious cause of death was considered anything that had a bacterial or viral component that was directly responsible for the neonate death. Aspiration pneumonia was considered an infectious cause because, in most cases, the aspiration of materials which contain bacteria were inhaled into the lungs and caused an infection within the lungs and sometimes septicemia leading to the death of the neonate.

Fading puppy and fading kitten syndrome was not considered a cause of death in this study. Fading puppy or kitten syndrome is a name given to describe a combination of several clinical signs which can lead to neonatal deaths but is not specific for a single disease entity.[4] Hypothermia,

hypoglycemia, anorexia, dehydration, etc. are all signs which would be included in fading puppy/kitten syndrome but could be caused by environmental, genetic, or infectious causes. There is no definitive mechanism described by the use of the term fading puppy/kitten syndrome and therefore it was not used as a cause of death in this study.

In this study, septicemia was found to be the number one identified cause of death among neonates. There are several routes of infection in the neonate which lead to sepsis. The most common causes of neonatal sepsis are tail docking, umbilical cord infections, respiratory infections, gastrointestinal infections, urinary tract infections, and skin infections.[4,6] In this study, 35% (6/17) of the deaths caused by sepsis were due to infection originating from the umbilicus. There was also one puppy that died of septicemia in this study from an esophageal perforation causing pleuritis, most likely secondary to complications with tube feeding. In one study it was found that *E. coli*, *K. pneumoniae*, and B-hemolytic *Streptoccous sp.* caused septicemia in suckling puppies from mothers with mastitis caused by the same bacteria.[7] The most common bacteria isolated from septic neonates are *Staphylococcus*, *Streptococcus*, *E. coli*, *Klebsiella*, *Enterobacter*, *Clostridium*, and *Salmonella*.[4] Predisposing conditions that lead to sepsis in neonates include inadequate colostrum, hypothermia and hypoglycemia, poor nutrition, viral infections, endoparasitism, or a dam with metritis or mastitis.[4]

Sepsis in the neonate is difficult to detect antemortem because clinical signs may be subtle. Some signs include crying and reluctance to nurse, as well as decreased urine output and cold extremities.[6] Treatment of sepsis includes aggressive fluid therapy and fresh or fresh-frozen plasma from a well-vaccinated dog or cat. This will help to boost the immune status to that of a regularly suckling kitten or puppy.[6] Electrolyte and blood glucose measurements are also important as well as adequate nutrition and environmental temperature. Antibiotics therapy should be based on culture and sensitivity.[6] Antibiotics commonly used in the neonate include cephalosporins, penicillins, clavulanic acid, macrolides, and trimethoprim-sulfonamides.[8]

Prevention of sepsis in the neonate is the key to decrease neonatal mortality. It is clear that the use of proper aseptic techniques is important in neonates in order to prevent infection and subsequent sepsis. Umbilical cords should be kept clean, properly ligated and dipped in an antimicrobial such as iodine to prevent umbilical infections. Owners should be advised of the importance of cleaning and properly handling the umbilical cords of the puppies or kittens when delivered at home. The importance of good hygiene and health of the dam should also be stressed. Many gastrointestinal and respiratory infections can be prevented by keeping neonates in a clean environment at the correct temperature and by keeping the dam well-vaccinated and healthy. Milk production should be closely monitored as well as color and character of the milk. The teats of the dam should be examined daily for signs of mastitis including heat, firmness, redness, or pain. By taking preventative measures and doing pre-whelping and post-whelping examinations on the bitch or queen, many of these causes of neonatal septicemia can be prevented.

Aspiration pneumonia was the second most common cause of neonatal death found in this study. Neonatal puppies and kittens have immature organ systems including their lungs and immune system. This puts them at high risk for developing infections, especially within the lungs. In several instances aspiration pneumonia was diagnosed based on the presence of protein globules with or without the presence of bacteria within the airways and tube feeding of puppies was suspected to be responsible for aspiration pneumonia. Tube feeding is needed when the neonate is too weak to nurse or the mother is unable to care for her litter. It is unclear in these cases whether the aspiration and death was due to the tube feeding itself or the condition predisposing the neonate to need to be tube fed. It is important that clients are properly informed and instructed on how to tube feed and the complications that may arise if it is done improperly. Clients should be taught what to look for if the puppies should develop aspiration pneumonia so they can begin treatment as soon as possible. With proper instruction and practice with the veterinarian, some causes of aspiration pneumonia can be avoided.

Signs of aspiration include milk replacer flowing out of the nostrils, difficulty breathing, coughing, and fever.[9] The neonate will be weak and lethargic and may be found separate from others in the litter. Bacterial pneumonia in the neonate should be treated with antibiotics. A transtracheal wash

can be performed and a culture and sensitivity obtained on the contents in order to select the most specific and effective antibiotic therapy. It is most beneficial to give antibiotics IV or intraosseous in the neonate.[4].

A number of reasons were found for inability to obtain definitive diagnoses. Maternal care that is degraded by poor health, condition, and behavior of the dam is one important factor that cannot easily be evaluated upon necropsy of the puppy or kitten. For example, if the dam suffers from agalactia and is not producing enough milk, several deaths can occur due to malnutrition of the neonates. On necropsy, there will be a lack of ingesta in the gastrointestinal tract suggesting that the neonate died of anorexia and hypoglycemia. However, there are several other reasons why a neonate may lack ingesta (including other illness in the neonate) and a pathologist would not be able to make a definitive diagnosis based on this finding alone. If this finding is consistent throughout an entire litter of neonates on necropsy, it can be more suggestive of a diagnosis of agalactia. The dam can also have other conditions such as mastitis or there may simply be some mismothering, which hinders the neonates' ability to thrive. All of these potential complications with the dam would make diagnosis based solely upon necropsy of the neonate difficult.

Hypoglycemia and hypothermia are significant causes of death. In general, they cannot be definitively diagnosed as a cause of death by necropsy. It is not possible to determine the antemortem temperature or blood glucose level of a neonate after it is deceased, and therefore a definitive diagnosis of hypothermia or hypoglycemia cannot be made.

Diagnoses were also not made because of severe artifacts within the tissues caused by freezing and thawing of the submitted specimens and by the method of euthanasia. The damage caused by these processes can mask a true cause of disruption to the tissues and prevent a diagnosis from being made. The amount of time that is allowed to elapse between the time of death and the time of tissue sampling is also very critical. The amount of autolysis that occurs is directly related to this time interval and the ability to make a diagnosis is closely related to the amount of autolysis present. The best way to maximize the chance of getting a diagnosis is to minimize the time between the death of the neonate and the time of tissue sampling.

There were three instances within this study where *in utero* fetal stress was suspected. When a neonate endures *in utero* stress, it is born weak and has a higher possibility of complications and failure to thrive. There may be no associated gross changes evident on necropsy but they will cause neonatal death within the first days of life. There are also causes such as suffocation, congenital cardiac arrhythmias, and complications with anesthesia during a cesarean section which may cause death but do not have specific lesions to allow for a definitive diagnosis.

In this study, 19 of the 31 cases in which the cause of death was unknown bacteriology or virology was not performed due to the request of the submitter. Thus 61% of the cases in which the cause of death was unknown did not have a complete examinaion. If the additional testing would have been permitted by the submitter, there is a greater chance that a diagnosis may have been made.

Many factors inhibited the ability to establish a definitive diagnosis, many of which may have been prevented. There are several things a veterinarian or animal owner can do to increase the chances of obtaining a diagnosis when submitting a sample for necropsy. Autolysis is one of the major factors that occurs postmortem that can hinder the ability to obtain a definitive diagnosis. Narrowing the time interval between the time of neonatal death and the time the tissue samples can be collected is crucial to improving the diagnostic quality of the tissues. The neonate should be refrigerated immediately after death, packaged properly, and sent to the diagnostic laboratory as soon as possible. Freezing should be avoided unless there will be an extended interval between death and necropsy in order to avoid the artifacts and damages that freezing has on the tissues. Also, the method of euthanasia should be taken into account if it is a necessary step. The best way to euthanize a neonate without disruption of tissues is IV injection of euthanasia solution.

A complete history should be submitted with every necropsy submission. Information about the dam, the whelping of the litter, the environment, and the health of the littermates are all important when establishing a diagnosis. It is important to know if the dam is vaccinated and if she has had any previous

health problems. Information about whether this is her first litter or if she has had previous litters and if there were any health concerns in previous litters are all important. Also, it is important to know if she had a natural delivery or if a cesarean section was required. The number of puppies or kittens that were in the litter and information on the status of the littermates are also valuable, as well as if there was neonatal mortality in previous litters. It is helpful to know about the neonates' environment. Was the area kept clean and isolated or were other animals in contact with the litter? Was the litter kept at an adequate temperature and was there any mismothering? It is also desirable to have complete history about the neonate itself. Information about its normality at birth and a specific timeline of events that occurred prior to its death is important in differentiating specific diagnoses. All of this information enhances the pathologists' ability to put together the pieces of the puzzle and determine a specific cause of death for the neonate.

There are several factors that need to be taken into consideration when evaluating the results of this study. The environmental factors of the Pacific Northwest vary significantly from other areas of the country including parasite load and prevalence of specific infectious diseases. Results from studies in other parts of the country may vary significantly. Also, the neonates submitted to WADDL were mostly purebred and most likely were submitted by breeders. This may skew the results from those found in the general population as many neonatal cadavers are not submitted to diagnostic laboratories.

References

1. Tønnessen R, Borge KS, Nødtvedt A, et al: Canine perinatal mortality: a cohort study of 224 breeds. Theriogenology. 2012;77:1788-801.
2. Grundy S: Clinically relevant physiology of the neonate. Vet Clin North Am Small Anim Prac 2006;36:443-459.
3. Lawler DF: Neonatal and pediatric care of the puppy and kitten. Theriogenology 2008;70:384-392.
4. Fortney W: Managing the sick neonate. Proc West Vet Conf;2007.
5. Lamm CG, Njaa BL: Clinical approach to abortion, stillbirth, and neonatal death in dogs and cats. Vet Clin North Am Small Anim Pract. 2012;42:501-513.
6. McMicheal M: Pediatric emergencies. Vet Clin North Am Small Anim Pract 2005;35:421-434.
7. Schafer-Somi S, Spergser J, Breitenfellner J, et al: Bacteriologic status of canine milk and septicaemia in neonatal puppies-a retrospective study. J Vet Med 2003;50:343-346.
8. Johnston SD, Root Kustritz MV, Olson PNS: The neonate-from birth to weaning. In: Canine and feline theriogenology. Philadelphia: WB Saunders; 2001. p. 200-224.
9. Cohn L: Successful treatment of bacterial pneumonia. Proc West Vet Conf; 2010.

Table : Causes of 107 kitten and puppy neonates death diagnosed at Washington State Animal Disease Diagnostic Laboratory during 2000-2010			
Diagnosis	Frequency	Percent (Frequency/107)	Infectious
Septicemia	17	15.8	Yes
Aspiration pneumonia	15	14.0	Yes
Infectious pneumonia	6	5.6	Yes
Prematurity	6	5.6	No
Anorexia	6	5.6	No
Congenital defect	6	5.6	No
Non-infectious pneumonia	4	3.7	No
Trauma	4	3.7	No
Canine herpesvirus 1 infection	2	2.8	Yes
Meningitis	2	2.8	Yes
Panleukopenia virus infection	1	0.9	Yes
Parvovirus infection	1	0.9	Yes
Endotoxemia	1	0.9	Yes
Clostridial myonecrosis	1	0.9	Yes
Cerebral hemorrhage	1	0.9	No
Infant respiratory distress syndrome	1	0.9	No
Infectious enteritis	1	0.9	Yes
Bacterial peritonitis	1	0.9	Yes
Intestinal intussusception	1	0.9	No
Unknown	30	28	