

CANINE AND FELINE NEONATAL RESUSCITATION: TECHNIQUES TO IMPROVE OUTCOME

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Average reported neonatal death rates (greatest during the first week of life) vary, ranging from 9-26%. Prudent veterinary and educated breeder intervention in the prenatal, parturient and postpartum periods can increase neonatal survival by controlling or eliminating factors contributing to puppy morbidity and mortality. Poor prepartum condition of the dam, dystocia, congenital malformations, genetic defects, injury, environmental exposure, malnutrition, parasitism and infectious disease all contribute to neonatal morbidity and mortality. Optimal husbandry impacts neonatal survival favorably by managing labor and delivery to reduce stillbirths, controlling parasitism and reducing infectious disease, preventing injury and environmental exposure, and optimizing nutrition of the dam and neonates. Proper genetic screening for selection of breeders minimizes inherited congenital defects. The neonatal period can be divided into the prepartum (prenatal) period, parturition, and the postpartum neonatal period, we will focus on the latter here.

Optimal neonatal resuscitation following birth (if the dam fails to do so) or caesarean section involves the same "A-B-C's" as any cardiopulmonary resuscitation. First, prompt clearing of airways ("A") by gentle suction with a bulb syringe or aspirator, and drying and stimulation of the neonate to promote respiration ("B"), and avoid chilling are performed. Neonates should not be swung to clear airways, because of the potential for cerebral hemorrhage (brain damage) from concussion. The use of doxapram as a respiratory stimulant is unlikely to improve hypoxemia associated with hypoventilation, and is not recommended. Spontaneous breathing and vocalization at birth are positively associated with survival through 7 days of age. Intervention for resuscitation of neonates following vaginal delivery should take place if the dam's actions fail to stimulate respiration, vocalization and movement within one minute of birth.

Cardiopulmonary resuscitation for neonates who fail to breathe spontaneously is challenging yet potentially rewarding. Ventilatory support should include constant flow O₂ delivery by facemask. If this is ineffective after one minute, positive pressure with a snugly fitting mask or endotracheal intubation and rebreathing bag (using a 2-mm endotracheal tube or a 12 to 16-gauge intravenous catheter) is advised. Obviously this is not possible in the home setting; piglet resuscitators or "one puff" ventilators are alternatives. Anecdotal success with Jen Chung acupuncture point stimulation has been claimed when a 25-gauge or smaller acupuncture needle is inserted into the nasal philtrum at the base of the nares and rotated when bone is contacted. Cardiac stimulation ("C") should follow ventilation support, as myocardial hypoxemia (low heart muscle oxygenation) is the most common cause of bradycardia or asystole (slow or absent heart rate). Direct trans-thoracic cardiac compressions are advised as the first step; epinephrine is the drug of choice for cardiac arrest/standstill (0.2 mg/kg administered best by the intravenous or intraosseous route). Venous access in the neonate is challenging, the single umbilical vein is one possibility, but thromboses (clots) quickly. The proximal humerus, proximal femur and proximomedial tibia offer intraosseous sites for drug administration in the clinical setting. Atropine is currently not advised in neonatal resuscitation. The mechanism of bradycardia is hypoxemia-induced

myocardial depression rather than vagal mediation, and anticholinergic induced tachycardia can actually exacerbate myocardial oxygen deficits (Making the heart beat faster without improving oxygenation makes things worse).

BEYOND THE ABC'S

Chilled neonates can fail to respond to resuscitation. Loss of body temperature occurs rapidly when a neonate is damp. Keeping the neonate warm is important during resuscitation and in the immediate post partum period. During resuscitation, placing the chilled neonate's trunk into a warm water bath (95 - 99°F) can improve response. Working under a heat lamp or within a Bair hugger warming device is helpful. Post resuscitation, neonates should be placed in a warm box (a Styrofoam picnic box with ventilation holes is ideal) with warm bedding until they can be left with their dam.

Neonates lack glucose reserves and have minimal capacity for gluconeogenesis (producing glucose metabolically). Providing energy during prolonged resuscitation efforts becomes critical. Clinical hypoglycemia involves blood glucose levels less than 30 to 40 mg/dl, and can be treated with dextrose solution intravenously/intraosseously, at a dose of 0.5 to 1.0 g/kg using a 5 to 10% solution; or a dose of 2 to 4 ml/kg of a 10% dextrose solution. Single administration of parenteral glucose is adequate if the puppy can then be fed or nurses. Fifty percent dextrose solution should only be applied to the mucous membranes because of the potential for phlebitis if administered intravenously; however, circulation must be adequate for absorption from the mucosa. Neonates administered dextrose should be monitored for hyperglycemia because of immature metabolic regulatory mechanisms. If a neonate is too weak to nurse or suckle, a mixture of a warmed, balanced crystalloid (half strength saline and 5% dextrose may be administered subcutaneously at a dose of 1 ml per 30 g of body weight, until the pup can be fed or nurses. Note that full strength saline or lactated ringers with 5% dextrose are hypertonic and not advised for neonates as dehydration can occur. A balanced warmed nutrient-electrolyte solution can be administered orally by stomach tube every 15 - 30 minutes until the neonate is capable of suckling.

WHEN TO STOP RESUSCITATION

1. No response after 15-20 minutes of effort (continued agonal respiration, bradycardia)
2. Serious congenital defect detected (cleft palate, loud murmur, gastroschisis (bowel outside the abdomen), large omphalocele (umbilical defect), large fontanel (soft spot)

HUSBANDRY: THE FIRST DAYS

Post resuscitation or within the first 24 hours of a natural delivery a complete physical examination should be performed by a veterinarian, technician or knowledgeable breeder. The oral cavity, haircoat, limbs, umbilicus and urogenital structures should be visually inspected. The mucous membranes should be pink and moist, a suckle reflex present, the

coat full and clean, the urethra and anus patent. A normal umbilicus is dry without surrounding erythema or urine. The thorax should be ausculted; vesicular breath sounds and a lack of murmur are normal. The respiratory rate should be regular and breath sounds quiet. The abdomen should be pliant and not painful. A normal neonate will squirm and vocalize when examined, nurse and sleep quietly when returned to the dam. Normal neonates will attempt to right themselves and orient by rooting toward their dam. Neonates are highly susceptible to environmental stress, infection and malnutrition. Proper husbandry is critical and should include daily examination of each neonate for vigor and recording of weight.

WARMTH

Puppies lack thermoregulatory (generating body temperature) mechanisms until four weeks of age, thus the ambient temperature must be high enough to facilitate maintenance of a body temperature of at least 97 degrees F (36° C). Hypothermia negatively impacts immunity, nursing and digestion. Exogenous heat should be supplied, best in the form of an overhead heat lamp. Heating pads run the risk of burning neonates incapable of moving away from excessively hot surfaces.

Neonatal Normal Body Temperature (rectal)

Week 1	95 - 99°F
Week 2-3	97 - 100°F
At weaning	99 - 101°F

Environmental Warmth Required

Wk 1:	84 – 89 ° F
Wks 2/3:	80 ° F
Wk 4:	69 – 75 ° F
Wk 5:	69 ° F

Chilled neonates must be re-warmed slowly (30 minutes) to avoid peripheral vasodilation and dehydration. Tube feeding should be delayed until the neonate is euthermic (the normal temperature), hypothermia induces ileus (lack of bowel motility) and regurgitation and aspiration can result.

IMMUNITY

Incompletely developed immune systems during the first 10 days of life make neonates vulnerable to systemic infection (most commonly bacterial and viral). Adequate ingestion of colostrum must occur promptly post partum for puppies to acquire passive immunity. The intestinal absorption of immunoglobulins generally ceases by 24 hours after parturition (birth). Colostrum deprived kittens given adult cat serum at a dose of 150 ml/kg sc or ip developed serum IgG levels comparable with suckling littermates, however colostrum deprived puppies given 40 ml/kg adult dog serum orally and parentally failed to match suckling littermate's IgG levels. 100 ml/kg is advised for puppies (0.10 ml/gm). Neonates should be encouraged to suckle promptly after resuscitation is completed; this usually necessitates close monitoring after a caesarean section as the dam is still groggy from anesthesia. Maternal instincts (protecting, retrieving, grooming, nursing) usually return within 24 hours.

The umbilicus of neonates should be treated with tincture of iodine immediately after birth to reduce contamination and prevent ascent of bacteria into the peritoneal cavity (omphalitis-peritonitis).

Neonatal bacterial septicemia can cause rapid deterioration resulting in death if not recognized and treated promptly. Factors that reportedly predispose a puppy to septicemia include endometritis in the bitch, a prolonged delivery/dystocia, feeding of replacement formulas, the use of ampicillin, stress, low birth weight (< 350 gms for a medium size breed), and chilling with body temperature < 96 degrees. The organisms most frequently associated with septicemia are E.coli, streptococci, staphylococci, and Klebsiella spp. Pre-mortem diagnosis can be challenging, clinical signs may not be noted due to sudden death. Commonly, a decrease in weight gain, failure to suckle, hematuria (bloody urine), persistent diarrhea, unusual vocalization, abdominal distension and pain, and sloughing of the extremities indicate septicemia may be present. Prompt therapy with broad spectrum, bactericidal antibiotics, and improved nutrition via supported nursing, tube feeding or bottle feeding, maintenance of body temperature, and appropriate fluid replacement are indicated. The third generation cephalosporin antibiotic ceftiofur sodium (Naxcel; Pharmacia and Upjohn) is an appropriate choice for neonatal septicemia as it alters normal intestinal flora minimally and is usually effective against the causative organisms. Ceftiofur sodium should be administered at a dose of 2.5 mg/kg sc q 12h for no longer than 5 days. Because puppies less than 48 hours old have reduced thrombin levels, presumptive therapy with vitaminK-1 may be used (0.01 - 1.0 mg SC per puppy) if abnormal bleeding is noted from the umbilicus.

GROCERIES

Neonates have minimal body fat reserves and limited metabolic capacity to generate glucose from precursors. Glycogen stores are depleted shortly after birth, making adequate nourishment from nursing vital. Even minimal fasting can result in hypoglycemia. Hypoglycemia can also result from endotoxemia, septicemia, portosystemic shunts and glycogen storage abnormalities. Oral fluid and glucose replacement may be preferable if the puppy has an adequate swallowing reflex and is not clinically compromised. The neonatal caloric requirement is 133 calories/kg/day during the first week of life, 155 calories/kg/day for the second, 175 - 198 calories/kg/day for the third and 220 calories/kg/day for the fourth. Commercially manufactured milk replacement formulas (Esbilac - Pet-Ag Inc, Elgin, IL; Puppy Milk Replacer Formula: Eukanuba, The Iams Co, Dayton OH; Veta-Lac Powder for Puppies: Vet-A-Mix, Shenandoah, IA, KMR- Pet-Ag Inc, Elgin IL) are usually superior to homemade versions. The use of milk obtained from the dam can be considered if available. An osmotic diarrhea (usually yellow, curdled stool appearance) can result from overfeeding formula, necessitating diluting the product 50% with water or a balanced crystalloid such as lactated ringer's solution. Neonates should gain weight steadily from the first day after birth (a transient mild loss from birth weight is acceptable on day 1); puppies gaining 1-3 grams per day per pound (2.2 kg) of anticipated adult weight and kittens 50-100 grams weekly. Neonatal weights should be recorded daily for the first two weeks, then every 3 days until a month of age. Healthy well nourished neonates are quiet and sleep when not nursing.

Normal Neonatal Weight Gain

Increase of 5 – 10 % body weight per day

Table 1: Veterinary Neonatal Resuscitation Kit

- Syringes (tb), acupuncture needles, small gauge needles (25-27)
- Epinephrine freshly diluted 1:9, 50% Dextrose freshly diluted to 5%
- Oxygen sources, piglet resuscitators, "first puff" ventilator system
- Suction (pediatric bulb syringes, de lee aspirators)
- Small face masks
- Towels (smallish and lots of them)
- Heat source (Baer, warm water blanket, infrared lamp)
- Puppy box (Styrofoam) with heat support
- Multiple clean mosquito forceps & small scissors
- 3-0 Gut Suture for umbilical cords needle removed, cut in 5" lengths
- Tincture of iodine
- Bowls for warm water baths
- Pediatric/neonatal stethoscope
- Doppler
- Neonatal scale

Neonatal Resuscitation Drugs

- Dilute epinephrine
- Dilute dextrose
- Ceftiofur
- Vitamin K1