EXAMINATION OF THE SMALL ANIMAL PEDIATRIC PATIENT

Margaret V. Root Kustritz, DVM, PhD, DACT
University of Minnesota College of Veterinary Medicine
St. Paul, MN 55108

Puppies and kittens are often neglected when they become ill. Financial constraints or lack of a functional relationship between the owner and pediatric patient may preclude the owners contacting veterinarians for assistance. Conversely, lack of experience in care of pediatric patients prohibits many veterinarians from encouraging breeders to present puppies and kittens.

HISTORY / PHYSICAL EXAMINATION

Historical facts that should be collected include duration of illness and clinical signs, number in the litter affected, any treatments given by the owner, and health and reproductive history of the dam.[1,2] Ascertain, if possible, whether the puppy or kitten has ingested colostrum. More than 90% of maternal antibodies are passed to the neonate via the colostrum.[3-5] Neonates should be encouraged to begin nursing within 2-3 hours of birth.[6] Maximal absorption of antibodies through the intestine occurs at 8 hours after birth, and decreases significantly by one day of life.[3] Serum IgG concentrations are low at birth, increase rapidly to a peak 18 hours after ingestion of colostrum, and then decline to a nadir at 3-4 weeks of age.[7,8] If the owner is unsure whether a puppy has ingested colostrum, blood can be drawn from the puppy of interest and a littermate that is known to have nursed, and serum alkaline phosphatase (AP) and gamma-glutyl transpeptidase (GGT) concentrations compared between the two. Concentrations remain high for up to 10 days in puppies that have ingested colostrum.[9]

If a puppy or kitten has not ingested colostrum, antibodies can be provided by subcutaneous administration of serum from the dam or another immunocompetent animal in the household. In a study of 43 kittens, comparing subcutaneous administration of antibody-rich serum to suckling, it was demonstrated that both techniques significantly increased protective antibody concentrations in kittens, compared to a control group that received no antibodies.[5] Pooled serum from vaccinated adult animals should be used. The empirical dose is 15 ml of serum, given subcutaneously as 5 ml boluses at birth and 12 and 24 hours later.[5]

The puppy or kitten should have been weighed at birth, and should be weighed daily thereafter. Low birth weight is correlated with poor viability. Kittens should weigh about 3.5 oz (100 gm) at birth.[10] Puppy birth weight varies by breed; estimates for various breeds are 4.2 oz (120 gm) for Pomeranians, 9 oz (250 gm) for Beagles, 17 oz (490 gm) for Greyhounds, and 22 oz (625 gm) gm for Great Danes.[6] Slight weight loss may occur in the first 24 hours of life. After that, the puppy or kitten should gain weight daily, doubling their birth weight by about one week of age.[11]

Rectal temperature varies with age and environment. Puppies and kittens may lose as much as 8.0°F (3.8°C) in the first day of life, even in a normal environment.[3] In the first week of life, brown fat is the main source of thermogenesis; after the first week, the shivering reflex permits some thermoregulation by the pediatric patient itself.[4] Normal rectal temperature is 96.0 +/- 1.5°F (35.6 +/- 0.7°C) in the first week of life, 98.6 - 100.0°F (37.0 - 38.2°C) in the second and third weeks of life, and gradually rises to adult levels by the age of seven weeks.[1,3,12]

In the first 2-3 weeks of life, puppies and kittens spend the majority of their time sleeping.[1] They huddle together or near the dam, and will not ordinarily sleep apart from littermates or the dam until 5-6 weeks of age.[13] When awake, neonates suckle vigorously. During examination, normal puppies and kittens easily can be encouraged to suckle the examiner's fingers or to root against the examiner's encircled thumb and forefinger.[1] The owner should be encouraged to handle the young animals regularly; careful handling of neonates may help stimulate development and sociability.[11] Caution should be taken to ensure that the dam is not disturbed by handling of her offspring. Assessment of poor muscle tone or observation of decreased activity should prompt veterinary intervention.[12] Pediatric animals that are observed to lie apart from littermates or the dam, that cry excessively, are extremely restless, or that are recumbent should be examined by a veterinarian immediately.[12]

Eyelids separate in puppies and kittens from 5-14 days of age.[1,11,14] Abyssinian kittens may exhibit eyelid separation substantially earlier (0-5 days of age).[1] Corneal cloudiness due to overhydration resolves within 2-3 weeks of eyelid separation.[2] Menace and pupillary light responses develop slowly, but should be present by 21 days of age.[2,14] Shirmer tear testing for adequacy of lacrimation can be performed any time after eyelid separation.[14] The retina and optic disc can be evaluated by about 6 weeks of age.[14] Electroretinography has been described for assessment of optic function; this technique can be used by 5-10 weeks of age.[14]

The external auditory canals open at about 6-14 days of age.[1,11,14] Immediately after opening, the epithelial cells lining the canals desquamate and the normal mixed flora develops.[2,14] A thorough otoscopic examination is possible in animals as young as 4 weeks of age.[4] Assessment of hearing in the clinic is difficult. Percussive hearing tests, such as hand clapping out of the animal's field of vision, are inaccurate due to lack of reaction in distracted animals with normal hearing (false negative) and reaction due to pressure changes in deaf animals (false positive). A BAER (brain stem auditory evoked response) test measures electrical potential from the cochlea, cochlear nerve and brain stem in response to auditory stimuli. Functional maturity of hearing, and an accurate BAER test, should be possible by 4-6 weeks of age.[14] If the test result is negative, the animal is functionally deaf. Partial deafness is more difficult to assess; changes in ability to detect high and low frequencies vary with age.[15]

Assessment of the entire skin and haircoat should be performed. Dermatologic conditions such as flea infestation and dermatophytosis are relatively common in young animals. The umbilicus falls off or is removed by the dam at 2-3 days of age.[14] The umbilicus

should be examined for evidence of infection. Traumatic inflammation of the appendages may occur if littermates are suckling on each other. Skin turgor is difficult to use as a measure of dehydration but dehydrated pediatric animals exhibit more wrinkling and less turgor of the skin, and deepening of the red color of the ventral abdomen and muzzle.[12] Other signs of dehydration include dryness of the eyes and oral mucous membranes, and visible yellow color of the normally dilute urine.[16]

Neurologic examination of pediatric patients is possible at birth, but neurologic function does not mature until 6-8 weeks of age. Normal neonatal puppies and kittens can crawl, suckle, vocalize if distressed, and respond to odor, touch and pain.[1] Withdrawal reflexes are present but slow at birth.[3] Flexor dominance is present until about 4 days of age; onset of extensor dominance varies from days 5-21.[2,12] Postural reactions, including non-visual placing, extensor postural thrust, and hemi-walking, are not fully developed until 6-8 weeks of age, and generally develop in the forelimbs before the hindlimbs.[2,14]

Palpation of the calvarium should be performed for assessment of closure of the bregmatic fontanelle. Persistence of an open fontanelle is not invariably associated with presence of intracranial disease (Table 1). Ultrasound through the open fontanelle for diagnosis of ventricular enlargement has been described in puppies as young as 3 weeks of age.[17-19]

Assessment of the musculoskeletal system includes evaluation of movement and palpation of the bones and joints. Puppies and kittens can lift their head at birth.[2] They crawl for the first 7-14 days of life, and should be able to support weight on their forelimbs by 10 days of age.[1,2] Locomotion is present by 3 weeks of age, allowing assessment of gait.[1,14] Muscle tone should be evaluated; decreased muscle tone often precedes other signs of illness.[12] Radiography for assessment of bone and joint abnormalities is difficult in puppies and kittens due to decreased mineralization of bone. Quality of radiographs may be enhanced by decreasing kVp to one-half that for an adult of the same thickness or, in puppies, by using 2 kvP for each 1 cm of soft tissue measured for values up to 80 kVp.[2,14]

The heart may be difficult to auscult in puppies and kittens, due to the small size of the heart and rapid heart rate.[1] Heart rate is ≥ 220 beats per minute in the first week of life.[2,14] Sinus arrhythmia is not described commonly.[14] Bradycardia is associated with hypoxemia in neonates.[3] Cardiac murmurs of grade I-III / VI, most commonly heard at the base of the heart on the left side, are often functional murmurs due to anemia, hypoproteinemia, fever or sepsis.[2,14] Congenital cardiac abnormalities usually are associated with murmurs of grade III-VI / VI and abnormal peripheral pulses.[14] Electrocardiography can be used to identify arrhythmias and conduction disturbances but accurate assessment of cardiac enlargement by measurement of mean electrical axes is not possible.[2,14] Echocardiography rarely is performed due to lack of appropriately sized transducers and measurements for pediatric patients.[2,14]

Lung sounds are ausculted easily with a stethoscope with a pediatric head.[1] Respiratory rate is 10-35 breaths per minute in the first week of life and reaches adult levels by 4 weeks of age.[2,3,14]

The deciduous teeth are present by 6 weeks of age. Permanent teeth erupt, displacing the deciduous teeth, at 4-6 months of age.[3]

Abdominal palpation should permit recognition of the left kidney, small intestines, colon and urinary bladder. If the spleen is palpable, splenomegaly is present. Hepatomegaly is present if the liver margin is palpable beyond the ribcage.[14] Abdominal distension often is due to aerophagia due to pain or respiratory disease, maldigestion, or retention of feces or urine.[1]

SAMPLE COLLECTION AND LABWORK

Venipuncture in pediatric patients can be difficult because the animal may be intractable and the veins are very small and collapse easily. Blood usually is most easily collected from the external jugular vein, although the cephalic vein may be used in larger puppies.[16] The femoral vein is too friable for venipuncture in pediatric patients.[16] The area over the vein should be moistened with water, not alcohol.[9] Puppies or kittens may be restrained either by pulling the forelimbs down over the edge of a table while extending the neck as for larger animals, or by laying the animal on its back, pulling the forelimbs toward the abdomen, extending the neck and introducing the needle toward the thoracic inlet.[9] Appropriate equipment is a 22-25 gauge needle attached to a 3 ml syringe.[9,16] Hemolysis and venous collapse are less likely if the needle is well seated into the vein and the blood is drawn slowly.[16]

The recommended minimum data base for assessment of sick pediatric patients is a hematocrit and total protein, blood glucose concentration, blood urea nitrogen, and urine specific gravity and sediment.[16] Contact the laboratory to find the minimum sample size needed. Blood volume in an animal weighing 1 pound (454 gm) is 25-40 ml.[4] In-house analyzers need smaller samples and have faster turn-around time than commercial laboratories but may have less rigorous quality control.[16]

The blood sample should be placed in a small diameter tube to ensure adequate mixing with any anti-coagulant present and to permit greater depth of serum or plasma to aspirate after centrifugation. Oftentimes, a greater volume of plasma than of serum is obtained from a given sample; green-topped (heparinized) tubes are preferred to red-topped (serum) tubes.[16] Purple-topped (EDTA) tubes should not be used since EDTA alters size and shape of red blood cells (RBC). The plasma sample should be removed from the clot as quickly as possible to prevent an artifactual decrease in glucose due to RBC metabolization and increase in phosphorus due to hemolysis.[16]

Urine can be collected by stimulating the genital area for a free catch or by very careful cystocentesis. Another technique is to allow the puppy or kitten to urinate onto a human

incontinence pad, remove the urine-soaked inner cotton layer, place it in a syringe and press out the urine with the plunger.[20]

COMPLETE BLOOD COUNT (Table 2)[1,2,4,21]

Hematocrit is normal at birth but declines in the early weeks of life due to decreased production and shortened RBC lifespan.[1] An increase in polychromasia, nucleated RBCs, Howell-Jolly bodies, and Heinz bodies (kittens) is evident.[14] Hematocrit is normal by 8 weeks of age.[1] A neutrophilia may be seen due to stress during venipuncture.

SERUM CHEMISTRY PROFILE (Table 3)[1-4,22]

Alanine aminotransferase (ALT) concentrations are decreased in young animals.[23] Alkaline phosphatase (AP) concentrations are increased by as much as two times adult concentrations, and remain elevated throughout rapid growth, peaking in kittens at 7 months of age.[16,23,24] Total protein (TP) is decreased in young animals as plasma volume expands faster than hepatic protein synthesis develops; TP is normal by 6-9 months of age.[16] Fasting and post-prandial bile acid concentrations are as adult concentrations by 4 weeks of age.[3]

Glomerular filtration rate is reduced in puppies and kittens, varying from 20% of adult values at birth to 100% of adult values by several weeks of age.[1,4] Blood urea nitrogen (BUN) values vary with relation of time of sampling to ingestion of the most recent meal, but BUN is still a more sensitive indicator of renal function than is creatinine in young animals.[3]

Neonates have maternal blood glucose concentrations at birth, then have a decrease in blood glucose to about 45 mg/dl in the first 4-6 hours of life, with stabilization at about 70 mg/dl by 72 hours of life.[25] Significant hypoglycemia is defined as a blood glucose concentration of < 50 mg/dl.[25] Pathologic hyperglycemia is uncommon in pediatric patients. Juvenile-onset diabetes mellitus has been reported in several breeds of dog and in one cat as young as 6 weeks of age, with blood glucose concentrations of 200-700 mg/dl, glucosuria, and clinical signs of disease including weight loss, polyuria, polydipsia, polyphagia, cataracts, and concurrent infections.[26,27]

Serum sodium concentrations may be decreased in the first several days of life but normalize quickly.[24] Phosphorus is elevated during rapid bone growth and is normal by 8-12 months of age; normalization may take longer in giant breeds.[16,24]

Thyroid hormone values may be elevated in pediatric patients. Serum thyroxine concentrations of 8-10 μg/dl were reported in 4-5 week-old puppies.[3]

URINALYSIS

Urine specific gravity is decreased in pediatric patients, at 1.006 - 1.017.[3] Physiologic proteinuria is present in the first days of life as colostral antibodies are absorbed and

excreted in the urine.[16] Normoglycemic glucosuria may be present until renal function matures.[16] Parameters described to decrease with age until approximating adult values include creatinine clearance; excretion of sodium, chloride, potassium and phosphorus; protein excretion; and protein:creatinine ratio.[28]

Table 1. Published characteristics of dogs with persistent bregmatic fontanelles[17-19]

	Sample size	Age (yrs; mean, range)	Breeds
Normal ventricle size, no clinical signs of neurologic disease	22	1.3 (3 wks – 9 yrs)	Shih tzu (15) Chihuahua (4) Lhasa apso Papillon Pomeranian
Ventriculomegaly, no clinical signs of neurologic disease	21	1.9 (3 wks – 10 yrs)	Chihuahua (11) Shih tzu (2) Toy poodle (2) Yorkshire terrier (2) Affenpinscher Lhasa apso Maltese Pomeranian
Ventriculomegaly, clinical signs of neurologic disease	25	2.8 (8 wks – 12 yrs)	Chihuahua (8) Maltese (5) Pomeranian (2) Toy poodle (2) Beagle Boston terrier Bulldog Dachshund Japanese spaniel Poodle mix Shih tzu Weimeraner Yorkshire terrier

Table 2. Complete blood count (CBC) values for puppies (P) and kittens (K)[1,2,4,21]

AGE (wks)	HEMATOCRIT (%)		WBC #* (x 10^3/µl)		DIFFERENTIAL (x 10^3/µl)											
	P	K	P	K	NEUTS*		BANDS		LYMPHS*		MONOS*		EOS*		BASOS	
					P	K	P	K	P	K	P	K	P	K	P	K
2	29-53	34-37	7-23	9-10	3-10	5-7	0-1	0-0.1	2-7	3-4	0-1	0	0-2	0-2	0	0
4	27-37	26-27	9-26	14-17	4-13	6-8	0-0.3	0-0.2	1-8	6-7	0-2	0	0-1	1	0	0
6	26-36	26-28	13-27	16-19	4-18	8-11	0-0.3	0-0.3	3-17	6-7	0-3	0	0-1	1	0	0
8	31-39	29-31	13-17	16-20	6-12	6-8	0-0.3	0-0.3	3-7	8-11	0-2	0	0-1	1	0	0

* WBC # = white blood cell number, Neuts = neutrophils, Lymphs = lymphocytes, Monos = monocytes, Eos = eosinophils, Basos = basophils

Table 3. Serum chemistry profile values in puppies (P) and kittens (K)[1-4,22]

AGE (wks)	ALT* (IU/L)		AP* (IU/L)		Albumin (gm/dl)		Total protein (gm/dl)		Glucose (mg/dl)		BUN* (mg/dl)		Creatinine (mg/dl)		Sodium (mEq/L)		Chloride (mEq/L)		Potassium (mEq/L)		Calcium (mg/dl)	
	P	K	P	K	P	K	P	K	P	K	P	K	P	K	P	K	P	K	P	K	P	K
2	10-34	11-24	176-560	68-269	2	2	4	4-5	111-146	76-129	---	< 30	---	---	---	---	---	---	---	---	---	---
4	20-22	14-26	135-201	90-135	1-2	2	4	5	86-115	99-112	---	<30	---	0.5	---	149-153	---	120-124	---	4-5	---	9-11
6	16-17	---	125-132	---	4-5	2	3-4	4-5	125-126	< 120	9	<30	1-4	0.6	148	151-156	105	119-125	5	5-6	11	10-11
8	9-24	---	144-177	---	2-3	2	4-5	5	134-272	< 120	---	<30	---	0.7	---	150-152	---	119-125	---	4-5	---	9-10

* ALT = alanine aminotransferase, AP = alkaline phosphatase, BUN = blood urea nitrogen