

Diagnosing hypoglycemia

A complete examination and diagnostic testing help safeguard puppies and kittens.



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Sometimes the most challenging cases presented to a veterinary hospital involve the youngest and most vulnerable patients, so veterinary professionals must recognize the normal and abnormal characteristics of a pediatric Pet. In the weeks following birth, puppies and kittens can face a variety of obstacles, including hypoglycemia, hypoxemia (secondary to birthing issues or cardiopulmonary disease), dehydration or hypothermia.¹ While each of these problems can present individually, a fair number of pediatric Pets with these conditions have compounding medical issues.

This article focuses on hypoglycemia as it relates to the pediatric Pet. The neonate is more apt to develop hypoglycemia than the adult Pet because of metabolic differences: increased glucose demands and decreased body fat, glycogen reserves and gluconeogenesis precursors.² And a variety of congenital and acquired diseases can cause hypoglycemia.

As you will discover, most sick puppies and kittens present with similar clinical signs, regardless of the underlying disorder.

The only way to determine the true cause of disease is by pairing a physical examination with diagnostic testing.

The healthy puppy or kitten

Before you can detect hypoglycemia—or any problem—in a pediatric dog or cat, you must be able to identify a healthy puppy or kitten. The 12-week pediatric period for dogs and cats can be divided into three stages:

- Neonatal (birth to 2 weeks)
- Infantile (2 to 6 weeks)
- Juvenile (6 to 12 weeks).³

As puppies and kittens develop through these stages, the normal ranges for certain physiologic parameters change (*Table 1*, page 25). Puppies and kittens also exhibit different physical characteristics as they grow and mature.

Neonatal puppies and kittens are born with their eyes and ears closed. They are unable to stand or support their weight, although their front limbs are useful for crawling. An open fontanel may be present, especially in toy canine breeds of this age and rarely in Persian kittens. It's possible that you will also find flexor dominance (*i.e.*, the reflex of the limbs flexing in

Table 1: Normal Parameters for Pediatric Pets

	Neonatal Period (0-2 weeks)	Infantile Period (2-6 weeks)	Juvenile Period (6-12 weeks)
Rectal temperature (°F)	96-99	99-102	100-103
Pulse rate (beats per minute)	200-220	Breed standards	Breed standards
Respiratory rate (breaths per minute)	15-40	15-30	Breed standards
Capillary refill time (seconds)	1-1.5	1-2	1-2
Packed cell volume (%)	32-50	25-30	26-40
Total protein (g/dl)	3.5-5.5	3.5-4.5	4-5
Albumin (g/dl)	1.5-3	1-2	2-3
Globulin (g/dl)	0.5-4	1.5-3.5	1-3
White blood cell count (x 10 ³ /μl)	9-25	8-16.5	10-18.9
Urine specific gravity	<1.020	1.020-1.040	Adult standards
Blood glucose (mg/dl)	50-150	60-150	60-250

response to scruffing), which is normal during the first three days of life. There are no teeth present at this stage, and vocalizations occur only when the Pet is hungry or awakened. Urination or defecation occurs only with external stimulation, typically by the queen or dam licking the puppy or kitten's perineal region.

A functional (also known as physiologic) murmur may also be present during the neonatal period. These murmurs are characterized as soft and occur early in systole. If you auscultate a functional murmur, it is typically loudest at the heart base on the left side of the Pet's thorax. A neonate's breathing should be even and unlabored.

Birth weights vary between breeds of dogs and cats. Healthy neonates should gain approximately 5 percent to 10 percent of their birth weight on a daily basis or from 1 to 1.5 g per day for each pound of their expected adult weight.⁵ The weight of

each puppy or kitten in the litter should not vary more than 25 percent from the average weight.

During the infantile stage, puppies or kittens experience significant growth, and breed variations become more pronounced. Their eyes and ears should be open and free of discharge. Mobility increases during this period, although it is still somewhat uncoordinated. A functional murmur may still be present. Murmurs in Pets with clinical signs of disease should be further investigated by ultrasound

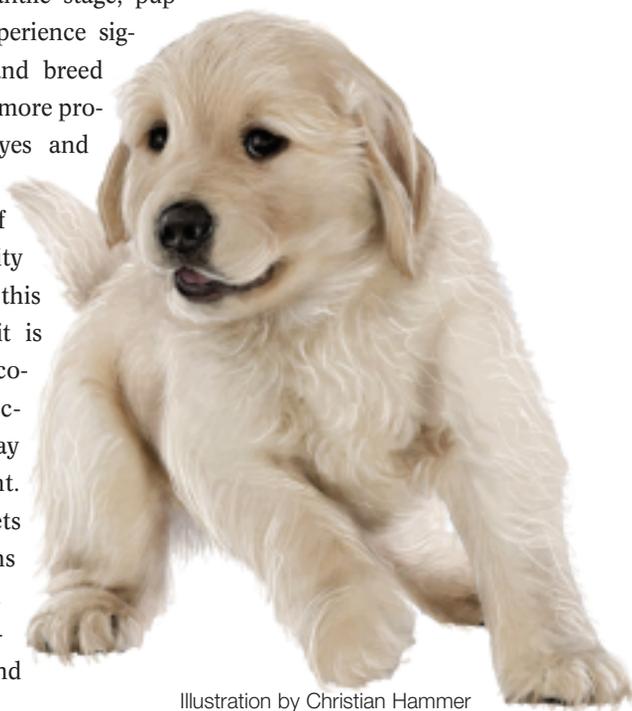


Illustration by Christian Hammer

whenever possible. The patient's breathing should be even and unlabored. Late in this stage, puppies and kittens will begin to vocalize normally, and their deciduous teeth will begin to erupt. Infantile puppies and kittens will also begin urinating and defecating autonomously.

In the juvenile stage, puppies and kittens resemble a young adult Pet of the same species and breed. Juvenile Pets should exhibit improved coordination and enjoy periods of high activity. It's possible that functional murmurs will still be present (and normal), but they should not be audible after 16 weeks of age. Any heart murmur

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auscultated after 16 weeks of age is not a normal physical examination finding and should be further investigated.

Hypoglycemia can be a major component of illness throughout any of the three stages of the pediatric period. Whether it's a primary disease or secondary to another illness, hypoglycemia can only be diagnosed through a thorough physical examination and diagnostic workup.

The physical examination

When you know the normal characteristics for pediatric Pets, it will be much easier to differentiate between healthy and sick patients. Pet owners usually recognize that their puppies or kittens are sick when their Pets are lethargic or unresponsive. The common clinical signs of hypoglycemia

include lethargy and unresponsiveness, as well as listlessness, vocalizing and seizure activity. A pediatric Pet's condition can change rapidly because of its small size and fragility. So when clients call about a sick pediatric Pet, treat their cases as emergencies. Stress the urgency of the situation and ask the owner to bring in the Pet and, if possible, the entire litter, including the dam or queen.

Before examining the Pet, ask the owner the following questions:

- When was the last time the Pet ate or nursed?
- Is this the first time the signs have occurred?
- Is the Pet showing any other abnormal signs (*e.g.*, diarrhea or vomiting)?
- Are any of the littermates exhibiting abnormal signs?
- Was this Pet the smallest in the litter?

When you proceed with the examination, use a pediatric stethoscope to auscultate the heart for rate, rhythm and the presence of murmurs. You should also check for any deformities, including a cleft palate. If the owner brought the littermates, use a gram scale to weigh them. Physical examination of the littermates might help you determine the cause of illness; however, it is possible for only one Pet to be affected. Examination of the sick Pet will likely yield the greatest results. Remember to differentiate normal examination findings from those that are abnormal during a specific pediatric stage of life.

The diagnostic tests

To diagnose hypoglycemia, you must perform laboratory evaluations, which can be challenging with a pediatric Pet. Jugular venipuncture is the easiest way to obtain a blood sample. To avoid hemolysis, use a

25-ga needle and 3-mL syringe to withdraw 0.5 mL of blood.

Keep in mind that kittens or small-breed puppies have a limited amount of blood, so it is important to obtain only the minimal sample needed. While the blood volume of a pediatric kitten or puppy is approximately 68 mL/kg, you can perform a wide variety of tests with just 0.5 mL of blood.⁴ It is usually safe to obtain up to 1 mL of blood from large-breed puppies or older puppies and kittens. Never use alcohol on small-breed puppies or small kittens when performing venipuncture because the evaporative cooling effect can drastically reduce the Pet's body temperature. A small amount of warmed water might be helpful when trying to part the coat to better visualize the vein.

Remember that hypoglycemia may be the primary disease, or it may be part of a larger disease process. Veterinarians should choose the diagnostic tests to perform based on the amount of sample available, the physical examination findings and any relevant history. The veterinarian's challenge is to unlock the mystery of the sick pediatric Pet by choosing the correct diagnostic puzzle pieces and interlocking them to form the bigger picture. The following parameters should be evaluated in sick pediatric Pets, including those with clinical signs of hypoglycemia.

Packed cell volume (PCV) and total protein levels should be determined using a microhematocrit tube. Remember to use age-appropriate reference ranges for interpretation (*Table 1*, page 25). The PCV and

total protein results will not reflect adult values until the Pet is 12 weeks old.

Albumin and globulin levels are a helpful way to characterize the total protein, depending on the blood sample available. Immediately at birth, albumin levels should be low-normal or slightly lower than accepted adult values, but globulin levels will be markedly low compared with normal adult values. The globulin level increases immediately after colostrum ingestion, but as colostrum effects wane, globulins will decrease to the lowest level at 3 to 4 weeks of age. From this point, globulin levels will begin to rise until adult values are reached at approximately 6 months of age.

Neonates tend to develop hypoglycemia because they have an increased demand for glucose, a lower reserve of body fat, lower glycogen reserves and decreased gluconeogenesis precursors.

White blood cell (WBC) counts should be determined by performing a manual differential on a blood smear. This method provides an estimate of the WBC count and requires only a drop of blood. Complete blood count analyzers may be used with larger sample volumes, but you should still evaluate a blood smear to ensure accuracy. The WBC count should be similar to adult values, although it can be in the normal to the high-normal range.

Granulocyte and lymphocyte counts are also valuable parameters to analyze from a manual differential. Neonates have a decreased ability to release granulocytes into circulation. If the Pet is sick and the granulocyte count is low or low-normal, consider the possibility of an infection. The

lymphocyte count can increase when the stress of blood collection induces epinephrine release. Keep in mind that nucleated red blood cells are a normal finding in puppies and kittens during the first few days after birth.

Blood glucose levels can be measured using a portable, whole-blood glucose monitor, which requires only a minimal amount of blood. Their use is controversial because the results tend to be slightly lower than those acquired by serum chemistry analyzers, as most portable machines are calibrated for human blood. The analyzation choice will likely be determined by both the blood sample size available and which machine is being used. While using a portable monitor might not be preferred, it may be necessary. If this is the case, keep the monitor's limitations in mind.

Glucose levels in pediatric Pets should be similar to adult Pets. Neonates tend to develop hypoglycemia because they have an increased demand for glucose, a lower reserve of body fat, lower glycogen reserves and decreased gluconeogenesis precursors. Low blood glucose levels can also be caused by an acquired illness (*e.g.*, septicemia, fatty liver syndrome or anorexia) or a congenital disease (*e.g.*, portosystemic shunt or glycogen storage disease).

Fatty liver syndrome usually occurs in toy breed puppies that have experienced a period of anorexia. Portosystemic shunts are most common in Yorkshire Terriers. Veterinarians have found glycogen storage disease in German Shepherds and many toy breeds, including Maltese. Furthermore, veterinarians often initially diagnose portosystemic shunts and glycogen storage diseases as hypoglycemia.

Remember, hypoglycemia can be either a primary disease or merely a symptom

of a larger disease process. Recurrence of hypoglycemia typically indicates a need to further evaluate the case. In breeds known for portosystemic shunts and glycogen storage diseases, specialized diagnostic tests may be warranted.

Urinalysis can also be an important part of the diagnostic process in pediatric Pets with hypoglycemia. Urine is typically easy to acquire by manually stimulating the urogenital area. Normal neonatal urine should be colorless and minimally concentrated with a specific gravity of less than 1.020, and it can contain glucose. Glucosuria found in patients up to approximately 8 weeks of age may be normal and is not usually a contributing factor for hypoglycemia. The kidneys do not achieve maximum concentrating ability (≥ 1.040) until the Pet is

approximately eight weeks old. Even if you are unable to complete a full urinalysis, it is important to ensure that the Pet is producing urine.

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Cytologic evaluation is another valuable test that can help determine the presence of infectious agents. To perform cytology, collect a sample from the nasal cavity (nasal discharge), the umbilicus (umbilical discharge) or the rectum (if diarrhea is

present). The amount of fecal material available may be insufficient to perform standard fecal analysis. In this case, you may wish to perform a direct fecal examination. Doing this will help you determine whether intestinal parasites are present.

Conclusion

To confirm hypoglycemia in pediatric Pets and determine the underlying cause, veterinarians must use a two-pronged approach that includes a thorough examination and diagnostic testing. Doctors should also examine and perform blood tests on the littermates. If the underlying cause is not determined, the clinical signs of hypoglycemia will likely recur. 🐾

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Suggested reading

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Become a master juggler to balance work and personal life

As a veterinarian, you live a demanding life. You face the pressures of career, family and social life, and hopefully you're carving out some time for yourself, too. Unless you make a conscious effort to balance all these demands, you may find yourself asking, "What social life?" Or you may discover you're not investing adequate time in your family or personal life.

The good news: You don't have to neglect your family or yourself. To successfully juggle your work and personal life, identify what you need to balance. Consider the following:

- The stage of your life
- Your definition of family
- Your life and career ambitions
- Your level of commitment to each part of your life.

Having a variety of interests increases your chance of happiness. To juggle effectively is to diminish the risk of depression and to gain better coping skills. A good resource is *Juggling* by Faye J. Crosby, which is the source of one of my favorite quotes: "Anyone who wishes to combine domestic responsibilities and paid employment with the least stress and most enjoyment might start by pondering this paradox: The first step to better functioning is to stop blaming yourself for not functioning well enough."

—Kathy Engler, DVM, DABVP, Director of Veterinary Career Development, Banfield, The Pet Hospital