Neonatal medicine can be challenging due to size but very rewarding. It is important to understand how normal parameters vary with age and other special considerations when providing nursing care for such a young, fragile patient. Physical exam parameters, drug dosages, laboratory data, and diagnostic imaging are sometimes very different in neonates than in adults of the same species.

Normal vitals for neonates are slightly different than older puppies or kittens and adults. Puppies and kittens are considered neonates from birth until two weeks of age. They are considered an infant from the time period of two to six weeks of age. Neonates may have more hyperemic gums for the first 4-7 days. The rectal temperature of puppies and kittens at birth is significantly lower than normal at birth. The temperature typically is between 95 and 99 degrees Fahrenheit. It should gradually increase over the course of the following four weeks. At this time it should be within normal limits. Heart rate is elevated in neonates in comparison to larger puppies or adults. It also normalizes by four weeks. Neonatal puppy heart rate should be around 200 bpm. Neonatal kitten heart rate is around 250 bpm. On the other hand, respiratory rate is typically lower at birth (around 15 bpm) and gradually increases to 30 bpm within the first few hours after delivery.

Neonatal monitoring and emergency treatment includes assessment of all of the body systems. A pediatric stethoscope should be used if one is available. It is normal for a minor, innocent heart murmur to be present at birth. It should resolve by 12 weeks of age though. When ausculting the lungs there is increased interstitial fluid at birth. If the neonate is going to be administered IV fluids it may be beneficial to get baseline thoracic radiographs.

Special considerations should be acknowledged when obtaining a blood sample for diagnostics. A patient’s total blood volume is 10% of its body weight. This is helpful in determining a safe volume of blood that can be sampled for diagnostics. In cats, the total blood volume is equivalent to about 60 ml/kg. Dog blood volume is approximately 90 ml/kg. Staff should not draw anymore than about 5% of the total blood volume in a 24 hour period in neonates. It is safe to draw 10% of the blood volume in adults. For an example a puppy weighing 0.5 kg has a total blood volume of 45 ml. This means that no more than 2.0 ml of blood should be sampled from this puppy. A kitten weighing 0.1 kg (100 grams) has a total blood volume of 6 ml. Therefore, only 0.3 ml of blood total can be sampled from this kitten in 24 hours! Take the value into consideration when prioritizing diagnostics. A quick estimation of amount of blood that can be sampled in 24 hours can be determined in puppies by multiplying their weight in pounds by two. For kittens a quick estimate is that the amount of blood that can safely be sampled is equivalent to its weight in pounds.
When reviewing bloodwork it is important to take into consideration some variations in bloodwork values. Bilirubin, ALP, GGT, phosphorus and calcium are typically higher in younger patients. BUN, creatinine, albumin, total protein and cholesterol may be lower in younger patients. Typical changes on a complete blood count include an increased white blood cell count. This may exist for up to 8 weeks of age. It can be elevated as high as 23,000. Eosinophil count may be increased due to the presence of intestinal parasites. Lymphocytes may also be elevated because of active antibody formation. The PCV is within normal adult ranges around 48% at birth but then decreases to around 30% by one month of age. It will then increase again after one month. If a urinalysis is being performed it is important to know that puppies and kittens are isosthenuric until about 10 weeks of age.

Radiographic changes that be seen with neonates include cardiomegaly, increased interstitial fluid in the lungs. The liver sometimes appears enlarged on abdominal radiographs because there has not been costochondral mineralization. There may also be a generalized lack of detail in the abdomen due to lack of fat and abdominal effusion. A tip that may be helpful is to decrease the KVP by half when taking abdominal radiographs.

There are several factors that are key indicators that a neonate is not doing well. Crying is normal for puppies and kittens. However, crying for more than 20 minute periods is abnormal. Extreme lethargy or lifelessness is an indication that veterinary help should be sought. Weight loss or failure to gain weight indicates that something is wrong. The only time that weight loss is normal is within the first 24 hours following birth. It is normal to lose 10% of their body weight during this time period only. An initial birth weight should be recorded. Puppies and kittens typically double their weight within the first 10 days of life. Thereafter puppies gain about 5-10% of their weight per day. Kittens gain about 10-15 grams per day after the first 10 days. Puppies and kittens should be weighed on a gram scale in order to get the most accurate weight.

There are four main reasons for presentation of a neonate to the emergency room. They are hypovolemia/dehydration, hypoglycemia, hypothermia and hypoxemia. Hypovolemia causes typically include, vomiting, diarrhea, anorexia or lack of intake. It is important to know that neonates with hypovolemia do not respond in the same manner as an adult with hypovolemia. In adults the normal systemic response to hypovolemia is to increase heart rate, concentrate the urine and decrease urine output. Neonates are unable to respond in the same manner. They have poor contractility of the heart due to lack of myocardium development. They also have immature sympathetic nerve fibers. The autonomic nervous system does not fully mature until about 8 weeks of age. Concentration and dilution of urine in response to hypovolemia does not occur until about 10 weeks of age. There are special considerations when evaluating hydration status of a neonate. When assessing the neonate for azotemia they are isosthenuric until 10 weeks of age. BUN and creatinine are normally low. This makes it very difficult to monitor azotemia.

Baseline thoracic radiographs should be taken prior to starting fluid therapy. Therefore repeat radiographs are easier to interpret if fluid overload has occurred. Skin turgor in neonates is not an accurate assessment of hydration alone because of the increase in water content of their skin. Moisture level of mucous membranes alone is also not a great diagnostic tool, as their mucous membranes typically remain moist despite considerable dehydration.
Fluid therapy can be administered in a couple of different manners. IV catheter placement is the desired method. A 24 gauge catheter can be used. It may be helpful to use a 20 gauge needle to make a puncture before inserting the catheter, as they tend to burr easily. If an IV catheter is unable to be placed an intraosseous catheter is the next best method for fluid delivery. Intraosseous (IO) catheters can be placed in the proximal humerus or femur. An 18-22 gauge spinal needle or an 18-25 gauge hypodermic needle is sufficient. It is possible to aspirate through the IO catheter after placement to obtain a blood sample if needed. Intraosseous catheters should be used temporarily. IV catheter placement should be attempted to be placed after two hours of fluid therapy through the IO catheter. They are generally safe for use for 24 hours though.

There are some other considerations to be made when delivery fluid therapy to a neonate. The fluids for rehydration of a neonate are higher for several reasons. Their bodies are comprised of a larger percentage of water and therefore require more fluid per weight. They have a greater surface area to body weight ratio. Neonates have less body fat and a higher metabolic rate that would require more fluids. Their skin is more permeable so more fluid is needed for maintenance. Lastly, neonatal kidneys have a decreased ability to concentrate the urine. The initial shock dose for a neonatal kitten is 30 mls/kg and 20 mls/kg for neonatal kittens. The fluids should be warmed using a fluid line warmer to keep the temperature consistent and constant. A guideline for maintenance fluids is 80-100 ml/kg/day. This rate should be adjusted considering losses if vomiting or diarrhea is ongoing. To get an idea of fluid loss, two tablespoons of diarrhea is equivalent to 30 mls of fluid. LRS is typically the fluid of choice in neonates due to the larger amount of lactate. It is the metabolic fuel of choice for neonates especially if hypoglycemic.

Hydration should be monitored closely to avoid fluid overload. Patients should ideally be weighed every six hours. PCV/TS can be used to assess hydration. It is important to remember that the PCV normally drops to around 28-30 after the first day of birth. Lactate can be used for monitoring but it should be trended. Lactate is normally higher in neonatal puppies than adults. Lactate level in puppies usually measures around 3.5 mmol/l. Hypovolemia can be monitored through temperature, mentation, pulse quality, mucous membrane color, blood pressure and trend of lactate. To measure the blood pressure in a neonatal puppy the rear limbs or the base of the tail should be used. The metacarpals or the base of the tail should be used for kittens. Cuff should be about 40% of the circumference of the limb or tail. If too small of a cuff is selected the reading may be falsely elevated. If the cuff is too large the blood pressure may be falsely decreased. It is important to record the size of the blood pressure cuff, the limb that was used and the location of the crystal in the medical record when taking serial blood pressures. Several readings should be obtained to get an accurate idea of what the blood pressure is. It is important not to tape the cuff all the way around, as it will obstruct it when inflating. Normal blood pressures are not the same as in adults. In adults systolic should be 110-160 mmHg, Diastolic should be 70-90 mmHg and mean arterial pressure should be 85-120 mmHg. The mean arterial pressure in a 4 week old is 49 mmHg. The MAP normalizes to around 95 mmHg at 9 months of age. It is important to know that adults are capable of regulating renal blood pressure with variations in systemic arterial pressure to protect the kidneys. Neonates do not have this capability. Glomerular filtration rate decreases in neonates when blood pressure decreases.
Neonates and pediatric dogs and cats are prone to hypoglycemia. This is due to an immature liver that has very little glycogen stores. They are unable to efficiently make glucose. They expel glucose in urine up to three weeks of age. Therefore, their glucose requirements are higher. The most common causes of hypoglycemia are anorexia, vomiting, diarrhea and infection. A common cause of diarrhea is overfeeding. Hypoglycemia is treated with administration of dextrose. 1-2 ml of 5-15% dextrose can be given orally. 1 ml/kg of 50% dextrose diluted with equal parts of 0.9% NaCl to make 25% IV can be given. They likely will need to be maintained on 2.5-5% dextrose CRI. If a CRI is not started the patient is at risk for rebound hypoglycemia. Carnitine may help with glucose utilization. 200 mg/kg PO every 24 hours can be given to both puppies and kittens. In conclusion, neonates have an increased need for glucose, an increase in loss of glucose and a decreased ability to make glucose in comparison to adults of the same species.

Hypothermia is another common presentation. This is due to the neonate’s large surface area to weight ratio. They are unable to shiver for the first 6-8 days of life as well. Neonatal metabolism is decreased so it is hard to maintain heat. Temps should be taken every 20 minutes. Hypothermic neonates should be warmed slowly over 1-2 hours. If an incubator is available is should be kept at 85-90 degrees Farenheit. Humidity should be maintained at 55-65%. A warm water enema can be administered if needed. If warm water bottles or heating pads are used the neonate should have enough area to move away if desired. Heat sources should be covered with a towel.

Hypoxemia is the fourth most common presenting exam finding. Pulse oximetry should be obtained. The normal locations that you would take a pulse ox reading on an adult can be used. The hairless skin on the abdomen can also be used. Care should be taken with oxygen therapy to avoid oxygen toxicity. Excessive oxygen therapy can cause retrolental fibroplasias which may cause permanent blindness.

Respiratory distress in the neonate is due to pulmonary hypertension (possibly from congenital defect), immature lung tissue (decreased surfactant levels in the lungs), fluid in the airways and possibly aspiration of meconium. The first step in treating respiratory distress in the neonate is to reverse any drugs that may have been used with a cesarian surgery. If there is suspect fluid accumulation in the airways the mouth and pharynx can be suctioned with a small bulb syringe (infant nasal aspirator). Be careful not to use too much suction, as laryngospasm can occur or the patient can have a vagal response. Rubbing the patient gently can stimulate respirations. Doxapram given underneath the tongue can also be used to stimulate respirations. Lung expansion causes the release of surfactant so if the patient is not breathing at birth it should be intubated and ventilated. Pediatric ambu bags are available. Neonates should receive 25 bpm.

If there is no heart beat CPR can be started after 15 seconds of breathing. Chest compressions can be done with the thumb and forefinger of the same hand. Compressions should be given at a rate of 100-120 per minute. If an IV route cannot be obtained an intraosseous catheter should be place. This should be used as a temporary route for drug and fluid administration. An IV route should be established once the patient has been stabilized. Epinephrine may be used for resuscitation. 0.01 mg/kg of Epinephrine should be given for the first two doses utilized. Then the high dose of 0.1 mg/kg can be given thereafter.
Resultant acidosis can occur with patients not receiving adequate ventilation or perfusion. Increasing perfusion and ventilation will treat this. Myocardial contractility can be extremely affected by severe acidosis. This decrease in contractility is critical because neonates already have a decrease in contractility compared to adults. The use of sodium bicarbonate as a buffer is controversial as it can increase serum sodium levels and cause hyperosmolality. It should be used though after 10 minutes of CPR if needed.

Neurological examination is possible in neonates but puppies and kittens do not have mature neurological function until 6-8 weeks of age. Neonates can crawl and vocalize. They crawl for the first 7-14 days and then can support weight around 10 days old. Most are ambulatory by 3 weeks of age and gait can be assessed at this time. They can also respond to pain stimulus. Withdrawal reflexes should be present but slow. Postural reactions such as hemi-walking and conscious proprioception are not fully developed until 6-8 weeks of age.

In kittens neonatal isoerythrolysis should be considered. This is an immune-mediated disease that occurs when a kitten with type A blood drinks colostrum from a mother with type B blood. The antibodies contained in the colostrum are ingested and absorbed in the GI tract. The antibodies bind to the kitten's red blood cells and destroy them because they are recognized as foreign. Once the colostrum is ingested the kitten may begin to show signs of fading within hours to days. They stop nursing and do not grow. Pigmenturia (reddish brown urine) is a distinguishing characteristic of NI. The kittens will also become icteric (hemolysis induced) and anemic. They will be lethargic and/or depressed.

Neonates have a higher incidence of brain trauma. Care for neonates with head trauma include decreasing intracranial pressure, oxygen delivery, and to maximize cerebral perfusion pressure. To maximize cerebral perfusion pressure the mean arterial pressure should be increased, the intracranial pressure decreased. Fluid therapy should be initiated to maintain a blood pressure with a systolic reading above 90 mmHg. CO2 levels should be monitored and kept within normal range. The neonate should not be over or under ventilated. Seizures can happen after head trauma. The patient’s head should be elevated on a 30 degree incline. It is not recommended to use a towel underneath the head as it can compress the jugular veins, resulting in increased intracranial pressure. Neck bandages and central catheters placed into the jugular vein should also be avoided. Clinical signs of increased intracranial pressure in animals include hypertension with bradycardia. This is an unreliable way of diagnosing increased intracranial pressure in neonates as their autonomic nervous system is not mature until about 9-10 weeks of age. Overall, since it is hard to determine if the patient has increased intracranial pressure it is best to maintain optimal blood pressure through IV fluid therapy and vasopressors if needed, as well as elevating the head 30 degrees without compression of the jugular veins and maintaining adequate oxygenation and ventilation.

Lastly sepsis may occur in neonates. This can happen from open wounds, tail docking, umbilical cord ligation. Infections of the GI, respiratory and urinary tract may lead to sepsis. Viral infections may be to blame. Clinical signs associated with sepsis in the neonate are crying excessively, not nursing, lethargic, decreased urination and hypothermia. Recently studies have been performed that recognize the presence of microalbuminuria as a predictor for the development of SIRS. Because SIRS has been associated with increased capillary permeability and therefore albuminuria with glomerular inflammation. A urine albumin-creatinine ratio can be obtained. An increase in the urine albumin-creatinine ratio has been shown to be an early
indicator of SIRS. This is an inexpensive test that may identify sepsis in neonates. Treatment is through the main four points that were discussed. Treat the hypovolemia with aggressive fluid therapy, address the hypothermia and hypoglycemia and lastly provide oxygen supplementation if hypoxemic. Very aggressive initial fluid resuscitation has been associated with a decreased mortality in neonates. Septic patients have an increase in capillary permeability and vasodilation and therefore need larger amounts of fluids. A good starting point is 45 ml/kg of warmed isotonic fluids. Some studies have shown that giving fresh frozen plasma may benefit the neonate by providing some immunity. Frequent blood glucose and electrolyte monitoring will need to be done. Antibiotics will also be needed. A culture and sensitivity of the area of concern should be obtained prior to starting antibiotics if possible. First generation cephalosporins are a safe starting point with neonates and they provide coverage for gram-positive organisms as well as some gram-negative organisms. In neonates that are younger than 48 hours or puppies that are older but showing signs of hemorrhage Vitamin K should be given. Puppies have decreased thrombin levels at birth and are therefore more prone to bleeding. 0.01-0.1 mg SQ or IM of Vitamin K can be administered.

Overall, it is important to understand the differences in “normals” for neonates and pediatrics versus those for adults of the same species. Neonates generally have four main reasons for presenting on an emergent basis. Hypovolemia, hypoglycemia, hypoxemia and hypothermia are the main clinical findings at presentation. Correcting the underlying cause or illness and supportive care by the nursing team is important for survival in these patients.