

## Section VII Newborn Physical Examination

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The physical examination is critical to the identification and localization of abnormalities, recognition of complications, and monitoring progression or resolution of disease. Examination should be complete and performed in a systematic manner, regardless of whether it is for a new foal examination or suspected illness. Developing a complete, but concise, method of physical examination ensures that steps are not missed and provides a record that becomes essential when monitoring changes in a foal's condition.

### History

The history is important for interpreting examination findings and recognizing potential risk factors for disease. A comprehensive history is imperative, especially if the veterinarian is not familiar with the mare or client. The history includes information about the perinatal period, parturition, and course of events after the foal was born. The mare's reproductive history including number and health of previous foals, length of current and previous pregnancies, vaccination status, travel history, and concurrent medical problems during pregnancy should be collected. It is important to ascertain whether the mare has leaked colostrum prior to delivery or has produced other abnormal foals. It should be determined if parturition was observed and if assistance was needed for delivery, in addition to the time of birth relative to the time of the veterinary examination. Environmental conditions where the foal was born should be determined and caretakers questioned about the foal's behavior since birth and if nursing, urination, and defecation have been observed. Time to standing and first nursing are important to assess the vigor of the foal and document transitional milestones: sternal recumbency by 20 minutes, suckle response by 30 minutes, standing by 60 minutes, and nursing by 2 hours. Larger foals and male foals may take slightly longer to stand and nurse [1, 2].

### General Appearance

When examining healthy or non-critically ill foals, the mare and foal should be observed from a distance and nursing behavior, musculoskeletal abnormalities, and resting respiratory rate determined. The mare's attitude toward the foal should be assessed before entering the stall. Some mares will be indifferent, extremely protective, fearful of the foal, or extremely aggressive toward the foal. Maiden mares, older mares, Arabian mares of Egyptian ancestry, and mares that have a history of previously rejecting foals are most likely to reject foals [3]. Normal foals nurse in short bouts (90 seconds) up to 7–10 times per hour. Decrease in nursing or increase in recumbency should prompt a more detailed investigation. Dripping of milk or milk staining on the foal's head indicate inadequate nursing, while foals repetitively udder seeking and butting the mare suggests inadequate milk production. It is important to observe the foal's interactions with its dam and the environment as changes in behavior are an early predictor of sepsis or neurological dysfunction. In health, foals play after eating followed by recumbency and sleep. A decrease in activity or lack of response to external stimuli may be the first signal of illness.

After brief observation of the mare and foal, the foal's vital parameters are collected. Those handling the foal should wear exam gloves to decrease introducing pathogens into the foal's environment. The foal should be examined as to its general appearance and body condition. The normal gait of the neonatal foal, compared to an adult, is characterized by a base-wide stance, mild hypermetria, and a flexed head posture. Poor body condition typified by obvious ribs and bony prominences and a low birthweight may be present with either prematurity or intrauterine growth restriction [4]. In conjunction with gestational length, the physical characteristics of the neonate can determine if the foal is premature, dysmature, or small for

gestational age. Signs of prematurity should be noted and include short, soft hair coat, pliant lips and ears, laxity of the distal limbs, and a domed forehead [4].

## Vital Parameters

The order of the examination is not critical if a routine that ensures a complete and comprehensive examination is performed each time. Examination begins with determination of temperature, heart rate, and respiratory rate as these parameters are important determinants in assessment for presence of systemic inflammatory response syndrome (SIRS). The healthy foal's temperature is between 37 and 39°C (99–102°F) [2, 4]. Healthy, full-term foals can maintain body temperature at birth but are born with minimal subcutaneous fat and limited energy reserves. Foals that are slow to nurse may become hypothermic secondary to declining activity, low energy reserves, and increased heat loss secondary to a high surface area to body weight ratio. Low body temperature indicates the need for warming and occurs in critical foals with inadequate perfusion, sepsis, or SIRS and in healthy foals when the environmental temperature is low. Elevations in temperature frequently imply infectious disease, but caution should be applied if the temperature is mildly elevated and the foal was recently active such as evading a potential examiner. Altered body temperature is an indication for laboratory assessment of the foal.

At birth, the heart rate is 60–80 beats/min and will increase to 120–150 beats/min during the first 2 hours of life, often associated with the efforts to stand and ambulate. The heart rate should stabilize at 80–100 beats/min during the first 24 hours of life [4]. Respiratory rate is best determined by observation before entering the stall and should be in the range of 40–60 breaths/min soon after birth and decreases to 12–40 breaths/min within the first 24 hours [4].

## Examination of Head

Excessively pliant, floppy ears are consistent with prematurity, and petechiation present inside the pinna is supportive of thrombocytopenia, sepsis, SIRS, or disseminated intravascular coagulation (DIC). Normal mucous membranes should be pink and moist, with a capillary refill time of <2 seconds. Pale mucous membranes are seen with anemia or poor peripheral circulation. The presence of petechia or hyperemia is suggestive of SIRS, and supportive evidence can be garnered by examination of other mucous membranes. Additional signs of decreased perfusion and SIRS include prolonged capillary refill time, cool extremities,



**Figure 1.VII.1** Mucous membranes of a neonatal foal demonstrating cyanosis and prolonged capillary refill time. *Source:* Picture courtesy of Dr. Pam Wilkins.

coronary band hyperemia, episcleral injection, and declining activity (Figure 1.VII.1). Icterus is seen with hemolysis, sepsis, neonatal isoerythrolysis, severe liver disease, and infection with equine herpesvirus type-1. Cyanosis is rare and not seen unless  $P_{aO_2}$  is <40 mmHg and usually associated with severe cardiopulmonary disorders [5].

The incisors characteristically erupt at 6 days, 6 weeks, and 6 months for the central, middle, and corner incisors, respectively. In Miniature Horses and ponies, the middle incisors may not erupt until 4 months, and the corners may not be evident until 12–18 months of age. Dental abnormalities are uncommon except congenital abnormalities such as maxillary prognathism, mandibular prognathism, and wry nose. Mandibular prognathism may be seen in conjunction with congenital goiter. Wry nose may occur as a singular abnormality or in combination with more severe defects such as cleft palate, wry neck, and either mandibular or maxillary prognathism [5]. Severe deviations of the muzzle may interfere with normal nursing and be accompanied by inspiratory noise and breathing problems. The condition should be monitored to assess the development of dental malocclusion. Signs including nasal regurgitation of milk, coughing during nursing, and aspiration pneumonia are seen with cleft palate. The defect may involve both the hard and soft portions of the palate or the soft palate alone (majority). Digital palpation of the hard palate may identify large defects, but endoscopic examination is usually required to confirm defects of the soft palate. Other causes of nasal regurgitation of milk include pharyngeal weakness or incoordination. This condition is usually temporary, and affected foals can be managed by feeding through nasogastric tube until function is present.

The eyes should be examined for corneal ulcers since neonatal foals may not be able to close the eyelids completely, have decreased tear production and corneal sensitivity, and lack a menace response for up to the first 2 weeks of life [6]. The pupillary light response (PLR) is present but slow when the foal is excited or stressed.

During ophthalmic examination, persistent hyaline arteries are visible at the back of the lens, and the optic disc is pale pink or red. Additionally, Y-sutures are present in the lens for a variable period of life and in some instances persist into adulthood. Acquired lesions include subconjunctival and retinal hemorrhages that occur during parturition and typically resolve by 2 weeks of age (Figure 1.VII.2) [7]. The eyes should be examined for cataracts, and the anterior segment should be evaluated for episcleral injection, aqueous flare, hypopyon, and hyphe-mia, which are often seen in foals with infection (Figure 1.VII.3). Corneal ulcers may be missed during a casual examination since corneal sensitivity is less in the newborn as compared to adults and blepharospasm, tearing,



**Figure 1.VII.2** Neonatal foal with subconjunctival hemorrhages acquired during parturition. *Source:* Photo courtesy of Dr. David Wong.



**Figure 1.VII.3** Septic foal with aqueous flair. *Source:* Picture courtesy of Dr. Pam Wilkins.

and photophobia are decreased [6]. Additionally, recumbent foals and those with seizures are prone to corneal ulcers and should be stained daily to identify the ulcers and initiate appropriate treatment. Lower lid entropion is often concurrent with dehydration and may contribute to corneal ulcers. Entropion commonly resolves upon correction of dehydration; however, this condition will occasionally require surgical or medical therapy. Entropion can be corrected with several vertical mattress sutures placed in the lower lid or temporary injection of the lower lid with procaine penicillin to roll the lid out. The benefit of penicillin is that it gradually absorbs and may or may not need to be performed again.

Thyroid enlargement (goiter) may be present at birth and can be secondary to excess or deficient dietary iodine fed during gestation [8–10]. In western Canada and northwest United States, a syndrome of thyroid hyperplasia, mandibular prognathism, and musculoskeletal abnormalities has been recognized; affected foals have hypothyroidism. Risk factors include diets that are high in nitrate or deficient in iodine that affect the developing fetus during pregnancy [11, 12].

## Cardiovascular System

Examination of the cardiovascular system includes evaluation of visible mucous membranes, palpation of peripheral pulses, assessment of extremities for warmth, evaluation of limbs for edema, and cardiac auscultation. Dehydration is suspected when mucous membranes are tacky, eyes appear sunken, skin tent is prolonged, and urination is decreased in frequency or amount. Tenting of the skin of the eyelids is a more reliable location to evaluate hydration status than the neck. Poor pulse quality, prolonged capillary refill time (>2seconds), decreased jugular filling (>2seconds) and cool ears and distal extremities are signs of decreased peripheral perfusion and warrant further investigation and early intervention. Pale mucous membranes signify anemia or inadequate perfusion, while sepsis is associated with mucous membrane, sclera, ear, and coronary band hyperemia and/or petechiation. Cyanosis should prompt examination of the cardiovascular system and is not typically seen except in congenital cardiac defects with right to left blood flow. In addition to congenital heart defects, cyanosis can be caused by persistent pulmonary hypertension of the newborn (PPHN) and will demonstrate hypoxemia unresponsive to nasal oxygen insufflation.

Peripheral pulses can be felt under the jaw (facial artery), the medial aspect of the elbow (brachial artery), and along the lateral aspect of the metacarpus (greater metatarsal artery). Pulse quality does not always correspond to hypotension, but decreased pulses suggest decreased peripheral

perfusion [13]. The limbs and ears should be warm to the touch. If cool, then poor peripheral circulation is a possibility and can be associated with impending shock or other circulatory abnormalities. Blood pressure may be assessed indirectly with an oscillometry or Doppler-based devices placed over the coccygeal artery of the tail or the greater metatarsal artery. With such devices, the mean pressure is 95–101 mmHg during the first 3 days of life [14]. At birth, the heart rate is influenced by vagal tone and varies between 36 and 80 beats/min. Upon standing and over the first 2 hours of life, the heart rate will increase to 120–150 beats/min and will stabilize and remain at 80–100 over the first week of life [15]. Because of the relatively thin body wall, the apex beat and any detected murmurs are louder than in adult horses. Tachycardia increases cardiac output and is expected during periods of exercise or stress. Tachycardia also accompanies sepsis, hypovolemia, anemia, hypoxemia, pain, or primary cardiac disease. Bradycardia can be seen with hypothermia, hypoglycemia, and certain electrolyte abnormalities.

A loud machinery murmur is commonly heard at the left heart base for the first 72 hours of life and is typically associated with a patent ductus arteriosus (PDA) that will close as the transition to normal circulation occurs [15]. Murmurs that are loud (>grade 4/6), pansystolic, bilateral, diastolic, or right-sided are more likely associated with pathological, rather than physiological, causes [16]. In foals that are compromised, the presence of a PDA is more concerning as hypoxemia, septicemia, or endotoxemia, or severe pulmonary disease can trigger reverse flow through the ductus arteriosus. Arrhythmias are frequently heard in newborn foals but resolve spontaneously within the first 15–30 min of life [17]. Arrhythmias are thought to be secondary to high vagal tone and include ventricular premature complexes, ventricular tachycardia, atrial fibrillation, and supraventricular tachycardia. Listening to both sides of the thorax is necessary to detect right-sided murmurs that are more commonly associated with congenital heart defects. If murmurs or arrhythmias persist beyond the first week of life, further examination is recommended.

## Respiratory System

At birth, the initial respirations are gasping and rapid as the foal attempts to ensure full insufflation of the lungs; the respiratory rate may be as high as 60–80/min. Respirations rapidly decrease to 35–40 breaths/min within the first hour. In ambulatory neonates, examination of the respiratory tract begins from outside of the stall to determine respiratory rate and effort without inducing excitement by catching and restraint. Causes of tachypnea include meconium aspiration, bacterial or viral pneumonia, atelectasis

secondary to recumbency, rib fracture, or pleural effusion. Increased respiratory rates can also be observed secondary to nonpulmonary causes such as fever, pain, excitement, exercise, brain disease, respiratory response to metabolic acidosis, and transient idiopathic tachypnea [5].

The nares should be examined for patency and presence of discharge. If respiratory distress or respiratory noise are heard at birth, several uncommon congenital abnormalities should be considered such as stenotic nares, choanal atresia, subepiglottic cyst, or collapsing trachea. Congenital obstruction of nasal passages will result in inspiratory dyspnea, attempts to mouth breath, and flutter of the cheeks during exhalation. Immediate intervention is required to ensure a sufficient airway. Meconium aspiration will result in brown-orange discharge at the nares, and the airways should be suctioned with a soft catheter and dose syringe.

At birth, lung sounds are moist with end-inspiratory crackles. These sounds rapidly resolve as the foal stands. Accurate auscultation can only occur if the foal is standing or at minimum in sternal recumbency for several minutes. Increased harshness with an increase in respiratory rate can be associated with several systemic diseases that do not necessarily affect the lungs, and thoracic auscultation often underestimates possible pathology related to the lungs. Foals with mild to moderate lung disease may simply have decreased sounds or no changes until consolidation becomes severe; however, abnormal lung sounds such as crackles and wheezes are always indicative of pathology. The respiratory pattern and effort are more sensitive indicators than auscultation as to presence of respiratory disease. A gentle in and out motion is characteristic of normal respiration, while exaggerated intercostal movement with synchronous abdominal effort and an expiratory grunt typify dyspnea. Paradoxical movement of the chest and abdomen signify that the foal is approaching respiratory failure [4].

Healthy foals have a regular respiratory pattern while awake but may have an irregular respiratory cycle when sleeping. However, irregular or erratic respiratory patterns in conscious foals or in semi-comatose foals suggest central nervous system disease, metabolic or electrolyte derangements, hypothermia, and disorders in maturation. Irregularities include tachypnea, hypopnea, intermittent apnea, and apneustic breathing. Hypopnea in foals with central nervous system disease can result in severe respiratory acidosis and indicates a need for immediate ventilation or institution of respiratory stimulants such as oral caffeine or doxapram administered as a constant rate infusion [18].

During thoracic auscultation, the chest wall should be examined for possible rib fractures. Clinical signs consistent with rib fractures include localized edema and swelling, palpable crepitus, auscultation of a grinding or click, or subcutaneous emphysema if underlying lung has been

punctured. Affected foals may grunt during expiration and avoid lying on the affected side. The most common location is at or just dorsal to the chondrocostal junction over the third to fifth ribs [19]. The location of the fracture increases the likelihood of severe or fatal damage to the underlying heart and lung so affected foals should be handled with care. When fractures are suspected, ultrasound can confirm rib fractures, more readily than radiography, by identification of a “step” in the rib. Additionally, ultrasonography allows evaluation of damage to the underlying lung [19]. Surgery is frequently needed to repair fractures that involve two or more ribs or have visible movement of the chest wall at the site of the fractures.

## Gastrointestinal System

The abdomen should be auscultated over all four quadrants (flanks and ventral abdominal wall). Normal borborrymi can be heard every 10–20 seconds, and intestinal sounds are subjectively classified as normal, increased, decreased, or absent. Decreased sounds suggest ileus and can be due to inflammatory, ischemic or obstructive lesions. Increased motility is associated with bowel inflammation or early intestinal obstruction. Splashing sounds are normally heard in the upper right quadrant as fluid enters the cecum, but tympanic sounds or fluid sounds should be considered abnormal. Ballottement and percussion can be used to help identify increased fluid or gas, respectively. Repeated measurement of the abdomen at a marked location can be used to monitor progression of suspected abdominal enlargement.

Internal palpation is limited to digital examination of the rectum. When a foal is suitably relaxed, some abdominal structures can be palpated through the abdominal wall such as meconium impactions, fecaliths, intussusceptions and the urinary bladder or enlargement of the internal umbilical remnants; however, in most foals, ultrasonography is necessary to evaluate internal abdominal structures. Ultrasound can determine motility, intestinal distention, increased thickness of bowel wall, and increase in free fluid within the abdomen. The body wall should be palpated to determine integrity and identify umbilical or inguinal hernias. Inguinal hernias are more common in colts and present as fluctuant swellings that are easily reduced back into the abdomen when the foal is placed in dorsal recumbency. Strangulation of bowel is rare, but damaged bowel can be further investigated using ultrasound to identify a thickened edematous wall.

A nasogastric tube should be passed in foals with signs of abdominal pain or distention of undetermined etiology. When gastric distension is severe, passage of the nasogastric tube through the cardia can be difficult and

administration of lidocaine through the tube may facilitate passage into the stomach. Colic signs may resolve or be decreased after removal of accumulated gastric contents. Gastric reflux also may be present in foals not exhibiting colic signs. Causes of gastric distention include gastric outflow obstruction, which may occur secondary to severe gastric/duodenal ulceration, and functional or obstructive lesions of the small intestine. Functional ileus may be seen with a variety of conditions, including sepsis, hypoxic ischemic syndrome, prematurity enteritis, and overfeeding.

Normally, neonates pass dark brown and firm meconium within the first 1–4 hours of life (Figure 1.VII.4). After passage of meconium, feces become yellow and pasty. Some foals exhibit discomfort secondary to retained meconium. While attempting to defecate, affected foals will arch the back, stand with hind legs camped-under, and flag the tail. In contrast, urination is associated with a flat back and the hind legs stretch backward. While straining, the anus will protrude, and a hard pellet of meconium can be felt as it attempts passage through the anus. Digital rectal examination often confirms hard meconium in the rectum. Additional signs include colic and ineffective nursing. As nursing decreases, mares of affected foals will often stream milk. More prolonged obstruction may result in abdominal distention, and continued straining may cause a patent urachus. Affected foals that develop patent urachus should receive antiseptic care of the umbilicus and prophylactic antimicrobials [20].

The passage of feces is infrequent in foals and often not observed, so any observed increase in frequency or softening of feces is suggestive of developing enterocolitis. Signs of colic in a foal include grinding of teeth, rolling, dorsal recumbency, and straining after frequent posturing accompanied by tail flagging. More subtle signs include increased recumbency, with restless repositioning, twisting of head



**Figure 1.VII.4** Typical appearance of foal meconium.  
Source: Picture courtesy of Dr. Alessandro Migliorisi.

and neck, and frequent stretching. Additionally, increasing abdominal distention may be observed with impending enterocolitis, intestinal obstruction, or urinary bladder rupture. Failure to pass any feces accompanied by clear or white mucous upon digital rectal examination along with colic and progressive abdominal distention increases the suspicion of atresia ani. Similar signs in largely white foals with immediate ancestors exhibiting overo-color pattern is suggestive of lethal white syndrome.

## Urogenital System

After birth, the umbilicus breaks at a predetermined location when the mare stands or sufficient traction for other reasons is applied to the cord. The umbilical cord should be allowed to break naturally, but on occasion the placenta may be passed before the cord has broken. Rather than cutting, the umbilical stump should be immobilized close to the body wall, and the cord should be pulled until it breaks at 1–2 cm from the body wall. Sharp transection of the cord does not allow the umbilical vessels to stretch and then retract within the cord and is associated with increased risk of hemorrhage. If hemorrhage occurs, the cord should be ligated or clamped. The umbilicus should be dipped in 0.5% chlorhexidine solution (1 part 2% chlorhexidine solution; 3 parts sterile water) every 8 hours for the first 2–3 days of life. Chlorhexidine has greater residual activity than betadine solution but may cause delay in the drying of the umbilical stump [21, 22].

First urination occurs around 6 hours for colts and 11 hours for fillies with the initial specific gravity around 1.030. Subsequent urinations occur soon after nursing and are much more dilute because of the milk diet. Urine production is 150 ml/kg/d, and the urine specific gravity in hydrated foals should be <1.010 [23]. Red urine is suggestive of passage of blood, hemoglobin, or myoglobin in the urine and should prompt immediate laboratory assessment of the foal to determine the cause. Urinalysis, complete blood count, and serum biochemistry aids in identify possible causes of discolored urine. Urination behavior should be monitored, as rupture of the urinary bladder is not uncommon in foals. Clinical signs include straining, passage of small volumes of urine, progressive enlargement of the abdomen, and progressive inactivity with weakness, which may not be seen until 2–3 days of age. Abdominal ultrasound confirms free fluid within the abdomen, but abdominocentesis and demonstration that the fluid creatinine is double serum creatinine concentrations are necessary to confirm uroabdomen.

The external umbilicus should be examined and inspected for increased moisture, discharge, or enlargement. Sick and recumbent foals frequently develop patency

of the urachus, and urine can be seen dribbling from the umbilicus. The patent urachus will normally close after resolution of the inciting cause. The umbilicus should be dipped with 0.5% chlorhexidine solution to decrease bacterial contamination, but insertion of cauterizing agents into the urachus is not recommended. Umbilical hernias are relatively frequent in foals at birth and can be 2–6 cm in length, with most closing by day 4 after birth; however, foals can develop abdominal hernias at 5–8 weeks of age. If the contents are easily reducible, surgery is usually delayed until after weaning. Ultrasonography of the umbilicus is recommended in foals with discharge or enlargement of the external umbilicus, patent urachus, or onset of fever and lethargy. Potential infection of the internal umbilical remnants is suspected when structures are increased in size [24–26]. In normal foals, the umbilical remnants have their largest size at birth and regress linearly over time to 50% of original values by one month. The umbilical remnants continue to regress and are difficult to detect by 5–6 weeks of age [26].

Colts should be examined for the presence of both testicles in the scrotum and if inguinal hernias are present. Most hernias are unilateral, indirect, and easily reducible and rarely result in problems. Patience is recommended as most inguinal hernias will correct spontaneously by 3–4 months of age. If clinical signs of discomfort or the hernia contents appear to be increasing in size, surgical intervention is recommended. For the first month of life, the free portion of the penis is usually fused to the internal lamina of the prepuce, and exteriorization of the penis can be difficult.

## Musculoskeletal System

Examination of the musculoskeletal system includes palpation of all joints and growth plates of the limbs. Additionally, the coronary bands should be examined for hyperemia (coronitis) that may be observed in foals with septicemia. Joint distention and periarticular swelling are easiest to detect at the carpi, fetlocks, tarsi, and stifles, but increased fluid in deeper joints such as shoulders, hip, and elbows can be more difficult. Simultaneous palpation of structures on both sides improves the detection of abnormalities. Joint infection should be the primary differential for any distended synovial structure. Aseptic arthrocentesis with a total white cell count of >10,000 cells/μl supports a diagnosis of infection. The tendons are examined for contracture or laxity. Both conditions may negatively affect the foal's ability to nurse and are often associated with failure of passive transfer of antibodies.

Angular limb deformities can be seen in forelimbs, hindlimbs, or both. Most mild-to-moderate deformities

spontaneously correct but should be monitored for improvement. Severe flexural deformities or those that are not improving or worsening should be evaluated for surgical intervention (Figure 1.VII.5). Occasionally, luxation of the patella secondary to hypoplasia of the lateral femoral trochlear ridge is identified, and if bilateral, can result in a squatting stance (Figure 1.VII.6).



**Figure 1.VII.5** Foal with both angular limb deformity and flexor laxity. Source: Picture courtesy of Dr. Alessandro Migliorisi.



**Figure 1.VII.6** Neonatal Miniature Horse foal with bilateral luxating patellas; note the squatting stance as the foal tries to stand. Source: Picture courtesy of Dr. David Wong.

## Neurological System

Differences in foal behavior, response to restraint, and ambulation must be considered when evaluating the nervous system. Movements are often exaggerated, and foals will often become limp when excessively restrained. During handling, vigorous snapping of the mouth and urination are expressions of submissive behavior. Mouth snapping should not be confused with tooth grinding, teeth clenching, and continuous chewing movements, which are suggestive of pain or seizures. Foals spend a significant portion of time resting, but the foal should be easily aroused, respond to external stimuli, and demonstrate a strong suckle response. Early signs of neurological dysfunction may include loss of suckle, decreasing affinity for the dam, apparent blindness, aimless wandering, intention tremor, seizures, or coma. The head posture of a foal, compared to adults, is more flexed, and movement is jerkier and exaggerated in response to visual, auditory, or tactile stimuli. Cranial nerve evaluation is similar to adults, with a few notable exceptions. The menace response is a learned behavior and is not predictably present until 2 weeks of age. There may be a transition period where foals will demonstrate avoidance by moving their head away from stimulus without blinking. When examining PLR, the pupils should be symmetrical. When excited, foals may have dilated pupils that are poorly responsive to bright light, so caution should be exercised to not overinterpret a lack of PLR in an excited or stressed foal. The pupil of the eye may be oriented ventromedial compared to the palpebral fissure and does not assume the slight dorsomedial angle seen in adult horses until 1 month of age [27]. Cleft palate, weakness, or mild pharyngeal paralysis can result in nasal regurgitation of milk. Careful physical and neurological examination is necessary to determine the cause. Foals with neonatal encephalopathy or severe depression may stand with the tongue hanging out and will be slow to retract the tongue when stimulated.

The foal should be observed for interactions with the dam and environment to evaluate behavior, mental status, and gait. The newborn should be able to right itself into sternal recumbency within minutes of birth. Initial attempts to stand are accompanied by a base wide stance and exaggerated short strides, but the foal rapidly develops a gait typical of adults. A healthy neonate should be aware of people and will return to its dam when approached. When in lateral recumbency, foals demonstrate exaggerated spinal reflexes, and the forelimbs have increased extensor tone. During the first 3 weeks of life, a light pinch of the distal limb will produce an exaggerated flexion response and can be accompanied by a cross extensor response in the opposite limb; this is less obvious in the hind limbs as compared to the forelimbs. Patellar and

triceps responses are easily and consistently elicited in foals [27].

Facial grimacing, twitching, chomping, smacking of lips, head and neck rigidity, paddling, abnormal breathing patterns, or repetitive blinking with rapid eye movements are all signs of seizures. The most common cause of neonatal seizures is neonatal encephalopathy, but other causes include congenital malformations, viral and bacterial infections, trauma, metabolic derangements, hepatic encephalopathy, and idiopathic epilepsy. In addition to nervous system causes, hypoglycemia, liver, and electrolyte disorders can also cause seizures. Juvenile seizures may be seen in Arabian foals and congenital narcolepsy has been described in American Miniature Horses, Morgans, Shetlands, and Suffolks. Affected foals exhibit collapse and remain in lateral recumbency for several minutes in a sleep state and then recover without residual signs.

## Integument

Close examination of the skin should be made to note abrasions, congenital abnormalities, and discoloration around coronary bands that may suggest septicemia. Recumbent foals need to be examined frequently for pressure necrosis over the bony prominences of the elbows, hocks, stifles, and hips. Additionally, foals with septicemia may have linear dermal necrosis in the crevices of the lateral aspect of the hocks. Hydration can be estimated by evaluation of skin turgor, mucous membrane moisture, corneal moisture, and sunken globes within the orbit. Skin turgor is best assessed by tenting the skin of the upper eyelid since other areas in the foal are difficult to interpret.

## Viability Assessment and Apgar Score

The above describes physical examination in newborn and neonatal foals, but in 1952, pioneering anesthesiologist Virginia Apgar developed a scoring system to assist doctors

**Table 1.VII.1** Modified Apgar score for newborn foals.

| Parameter         | 0 Points         | 1 Point                   | 2 Points                 |
|-------------------|------------------|---------------------------|--------------------------|
| Muscle tone       | Limp extremities | Some flexion of limbs     | Sternal                  |
| Respiration       | Absent           | Slow or irregular         | ≥60 breaths/min, regular |
| Heart rate        | Absent           | <60 beats/min             | ≥60 beats/min            |
| Nasal stimulation | No response      | Grimace, slight rejection | Cough or sneeze          |
| Mucous membranes  | Cyanotic         | Pale pink                 | Pink                     |

and nurses in evaluating cardiopulmonary adaption in infants at 1 and 5 minutes of age. The Apgar score was developed as a convenient method of reporting the status of a newborn immediately after birth and to determine if resuscitation was needed; however, it does not assess the consequence of asphyxia, predict neonatal mortality or neurological outcome, and should not be used for that purpose [28]. The Apgar score has been modified for use in foals with observations also made at 1 and 5 minutes after birth. The 1-minute score is used to recognize intrauterine asphyxia and is used as a semi-quantitative measure of whether resuscitation is necessary (Table 1.VII.1) [29, 30]. A second Apgar score at 5 minutes determines response to therapy and whether more intense interventions are required.

Scores of 0–3 are seen in dead or near dead foals, and cardiopulmonary intervention should be initiated with the realization that if a heartbeat or respirations are not rapidly evident, then attempts at resuscitation should be abandoned. A score of 4–6 indicates severe depression, and stimulation, intubation, and manual ventilation should be undertaken. If heart rate is <60 beats/min, chest compressions are also recommended. A score of 7–8 indicates mild compromise, and foals frequently respond to clearing nostrils and vigorous rubbing. Normal foals will have scores of 9 or 10.

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