Practical Approach to Nutritional Support of the Dysphagic Foal

Virginia Buechner-Maxwell, DVM, MS, Diplomate ACVIM (LAIM)

Coordinating suckle-swallow and breathing activities requires a complex integration of motor and sensory signaling. This ability is only partly perfected in the newborn, and disease can disrupt this process easily, resulting in hypophagia or dysphagia. Nutritional support is an important component in the treatment of the sick foal, whether the animal is an orphan or accompanied by its dam. Indwelling feeding tubes designed for use in the equine neonate facilitate the delivery of enteral nutrition to foals that have developed dysphagia due to a variety of diseases. Providing nutrition through the enteral route is a relatively safe and inexpensive method of supporting the dysphagic neonate through its disease process. Careful management of the feeding tube and diet is essential to prevent complications such as enteritis or aspiration pneumonia in the foal. Author’s address: Virginia-Maryland Regional College of Veterinary Medicine, Duck Pond Drive, Virginia Tech, Blacksburg, VA 24061-0442; e-mail: bmax@vt.edu. © 2012 AAEP.

1. Introduction

The average neonatal foal has a strong suckle-swallow reflex that is apparent at birth and allows the foal to ingest its first milk meal within 2 hours or less of parturition. Since foals are born with minimal energy reserves, the ability to suckle-swallow is closely coupled with survival. The coordinated suckle-swallow reflex is a complex task that requires precise integration of muscle and nerve activity. In addition, the suckle-swallow reflex must be synchronized with the expiratory phase of respiration and is accompanied by a moment of apnea to minimize the risk of particulate inhalation. In foals, dysphagia results from compromised ability to swallow and/or suckle, and sick neonates of many species often demonstrate a concurrent loss of suckle and swallow as their disease state progresses. A dysphagic foal that presents for treatment accompanied by its lactating dam will require the same nutritional support as an orphan foal due to its inability to suckle and meet its nutritional needs. Dysphagia results from a variety of causes including structural abnormalities such as cleft palate or physiological dysfunction such as muscle weakness, stupor, or loss of neurogenic control. Regardless of the cause, treatment requires rapid intervention either in the form of enteral or parenteral nutrition. Enteral supplementation is the most practical and economic approach to providing nutritional support but depends on gut function and appropriate delivery to prevent complications associated with aspiration, gastrointestinal ileus, or infection. Additionally, administering long-term parenteral nutrition is not practical in a field environment, but simple formulations can be used to bridge the gap between the foal’s initial presentation and stabilization of the foal’s condition to the point where it can tolerate enteral support. Providing adequate nu-
dysphagia
Oro-pharyngeal
Aspiration in the Neonate

3. Dysphagia and Factors That Increase the Risk of
the pharynx. Execution of the suckle-swallow reflex
widen the soft palate; propel food (milk) into the
formation to move milk from a rostral to caudal posi-
tion and against the soft palate; lift, shorten, and
shorten, and widen the soft palate; propel food (milk) into
the pharynx; and elevate the larynx as the bolus enters
the pharynx. Execution of the suckle-swallow reflex
requires orchestration of approximately 20 muscle
groups and culminates in bolus transport, suspension of respiration, and airway protection. The whole pattern is completed in about 1 second in humans.1,3

3. Dysphagia and Factors That Increase the Risk of
Aspiration in the Neonate
Oro-pharyngeal dysphagia is defined as “difficulty in
initiating a swallow and/or moving a bolus (of food)
from the oral cavity into the esophagus.”4 The ability to perform a nutritive suckle in human infants
forms late in gestation, and coordination between
suckle-swallow and breathing is not fully developed
until well after birth. Several aspects of the human
neonate’s response suggest that normal newborns
are at greater risk for developing aspiration pneu-
monia as compared with older children or adults.
Human infants tend to demonstrate a diminished
cough response due to reduced sensation in the pha-
ryngeal and laryngotracheal areas. This phenom-
ena is referred to as “pharyngolaryngeal sensory blunting,” and the absence of this response is most
apparent when infants are stimulated while asleep.5
As a result of this impaired sensation, aspiration
does not always generate a cough response even in
normal newborns.3 This is considered a “silent”
form of aspiration. In addition, postpartum coordi-
nation between the suckle-swallow and breathing is
not well established, resulting in an increased risk
of micro-aspiration of food. This later condition is
difficult to detect because the majority of ingested
milk is swallowed. However, micro-aspiration has
been associated with the development of aspirating
pneumonia in human infants.

The gestational maturity of the infant also influ-
ences the possibility of aspiration, with premature
neonates at greater risk than full-term, fully
developed offspring. Human infants delivered at 34
weeks of gestational age are capable of complete oral
feeding, although some of these “near-term” infants
commonly display abnormalities in SSB reflex, and
those born at or before 28 weeks of gestation display
non-nutritive suckle activity but rarely execute a
coordinated suckle. In the human neonatal inten-
sive care unit, SSB maturation is encouraged by
using a number of techniques that involve position-
ing, partial support, and promotion of non-nutritive
suckling. This approach has generally been shown
by some researchers to decrease the time to matu-
ratation of the normal suckle pattern, decrease stress,
 improve weight gain, improve oxygenation, and pro-
mote coordination between breathing, suckling, and
swallowing, whereas others have failed to detect a
beneficial effect.6–13

4. Clinical Signs and Common Causes of Dysphagia
in Foals
Dysphagia is a common problem in sick neonatal
foals and requires rapid identification and interven-
tion. Obvious signs of dysphagia include the pres-
ence of milk in one or both nostrils, coughing during
or immediately after ingestion of milk, dribbling or
drooling milk from the mouth, and auscultable fluid
in the larynx or trachea during or immediately after
suckling. In humans, additional, less apparent
signs include oral retention of food (delayed swal-
low), poor lingual peristalsis, reduced laryngeal ele-
vation, incomplete epiglottal closure, impaired
closure of the vocal chords, weak pharyngeal peri-
stalsis, and incomplete opening of the upper esoph-
ageal sphincter.2 Although these signs are difficult
to assess in most foals, they serve to demonstrate
that dysphagia can result from a failure of any one of
the many steps required to execute an effective
suckle and swallow. In addition, a partial reduc-
tion in the foal’s capacity to execute any aspect of the
suckle-swallow reflex may place the animal at risk
for “silent” aspiration as described in human neonates.

Reported causes of dysphagia in the foal are listed in Table 1.

### 5. Managing the Dysphagic Newborn Foal

As previously described, the newborn foal is born with minimal energy reserves, making nutritional support an important part of the therapy plan for the sick neonate. The body composition of the newborn foal differs from the adult horse, which accounts for the foal’s inability to survive prolonged periods without nutritional support. Neonatal foals have greater body water, greater relative blood volume, and less body fat than adult horses, and these differences are accentuated in the premature foal. Glycogen serves as an energy source for anorexic neonates. However, hepatic glycogen stores in foals are minimal (<20 mg/g wet weight) as compared with sheep, rat, and pig neonates (90 to 120 mg/g wet weight)\(^ {14–16}\) and are only sufficient to maintain body temperature for about an hour.\(^ {17}\) Once glycogen stores are depleted, energy is derived from endogenous fat. This source is limited in newborn foals and is only adequate to maintain body temperature for a maximum of 24 hours.\(^ {18}\) Studies from other mammals also suggest that nearly 50% of fat in newborns is structural and not available as an energy source.\(^ {16}\) These findings emphasize the need to provide nutritional support to sick foals.

One of the primary reasons for dysphagia in the neonatal foal is septicemia. Septicemic foals demonstrate a reduction in milk consumption for a variety of reasons, including central stupor and inability to recognize the dam and/or the udder; weakness or pain contributing to the foal’s inability to remain standing, establish a secure latch onto the teat, and suckle; compromise of part or all of the SSB reflex; or inability to cease respiration for the period required to suckle (which occurs in foals with severe pneumonia). Although not well studied in foals, a correlation between severity of acidosis and loss of suckle has recently been described in diarrheic calves and serves to illustrate the relationship between disease state and ability to execute an effective SSB reflex.\(^ {19}\)

#### Step 1: Stabilizing the Dysphagic Foal

Because foals have minimal energy stores, dysphagia results in rapid deterioration in the overall condition of the foal. In animals that are hypoglycemic, dehydrated, and demonstrate signs of shock, the delivery of nutrition by the parenteral route will initially be required. In a field environment, intravenous delivery of isotonic crystalloid fluids containing 2.5% dextrose can aid in stabilizing the foal’s condition. Rapid infusion of solutions that contain higher concentrations of dextrose can cause an acute transient hyperglycemia and diuresis of the sick animal. In humans, the resulting hyperglycemia has been shown to be detrimental and to contribute to patient mortality, especially in those with central neurological disease.\(^ {20}\) Based on the pace at which gestational foals metabolize dextrose in utero, the recommended delivery rate is 6.6 mg dextrose/kg/min.\(^ {15,21–23}\) In a 50-kg foal, this translates into 330

---

**Table 1. Specific Causes of Dysphagia in Foals Categorized Based on the Site and/or Type of Lesion**

<table>
<thead>
<tr>
<th>Category</th>
<th>Examples of Specific Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>General weakness</td>
<td>Hypoglycemia</td>
</tr>
<tr>
<td></td>
<td>Electrolyte abnormalities</td>
</tr>
<tr>
<td></td>
<td>Respiratory disease</td>
</tr>
<tr>
<td></td>
<td>Any disease that affects general mentation</td>
</tr>
<tr>
<td>Muscle</td>
<td>White muscle disease</td>
</tr>
<tr>
<td></td>
<td>Hyperkalemic periodic paralysis</td>
</tr>
<tr>
<td></td>
<td>Polysaccharide storage myopathy</td>
</tr>
<tr>
<td></td>
<td>Inflammatory myopathy</td>
</tr>
<tr>
<td>Central nervous system (including stupor)</td>
<td>Hypoxic-ischemic encephalopathy</td>
</tr>
<tr>
<td></td>
<td>Sepsis/general disease</td>
</tr>
<tr>
<td></td>
<td>Cerebrovascular accident</td>
</tr>
<tr>
<td></td>
<td>Head trauma</td>
</tr>
<tr>
<td></td>
<td>Anoxia</td>
</tr>
<tr>
<td></td>
<td>Degenerative neurological disease</td>
</tr>
<tr>
<td></td>
<td>Tumor</td>
</tr>
<tr>
<td>Neuromuscular junction disease</td>
<td>Botulism</td>
</tr>
<tr>
<td>Anatomic anomaly</td>
<td>Cleft palate</td>
</tr>
<tr>
<td></td>
<td>Persistent epiglottic frenulum</td>
</tr>
<tr>
<td></td>
<td>Pharyngeal diverticulum</td>
</tr>
<tr>
<td></td>
<td>Choanal atresia</td>
</tr>
<tr>
<td>Trauma/Injury</td>
<td>Tongue infection, laceration</td>
</tr>
<tr>
<td></td>
<td>Fractured or luxated jaw</td>
</tr>
<tr>
<td></td>
<td>Pharyngeal/laryngeal trauma</td>
</tr>
<tr>
<td></td>
<td>Esophageal trauma</td>
</tr>
</tbody>
</table>
mg/min or 20 grams of dextrose per hour. One liter of 2.5% dextrose provides 25 grams of dextrose and should be delivered to a 50-kg foal over about 75 minutes. In dehydrated foals that require more rapid fluid replacement, the concentration of dextrose can be decreased to maintain the appropriate dextrose delivery rate. After administration, the foal’s blood and/or urine glucose concentration should be measured before additional fluids containing dextrose are provided to make sure that the animal is not hyperglycemic.

Twenty-five grams of dextrose supplies the foal slightly less than 100 kcal of energy. The energy requirement of a healthy neonatal foal is 120 to 159 kcal/kg body weight per day; the needs of a sick foal are closer to 45 kcal/kg body weight per day. These needs cannot be met by delivery of 2.5% dextrose solution alone and can only be achieved by parenteral diets that contain a combination of lipids, amino acids, and dextrose. The formulation and administration of parenteral nutrition has been described elsewhere and will not be covered in this lecture. In many cases, short-term delivery of 2.5% dextrose serves to “kick-start” the foal and provide support while enteral nutrition is introduced.

It is now a universally accepted concept that when tolerated, providing nutrition by the enteral route is the most effective way to feed sick animals and people. The enterocytes that line the gut depend mainly on luminal contents for their nutrients. Some studies have shown that the protective barrier provided by these cells starts to fail within a couple of days of food withdrawal in otherwise healthy animals, even when caloric needs are met through the parenteral route. In foals, selecting the enteral route is more economical and a less risky method of feeding the animal and allows the foal to continue to consume the mare’s milk (when it is available). Under certain circumstances, maintaining an enteral feeding protocol is possible without having to hospitalize the animal, whereas providing nutrition by the parenteral route is much more difficult to do in the field.

Before deciding if the enteral route is the correct delivery route for the sick neonate, the foal’s general clinical status and gut motility should be assessed. Sick or shocky foals often have a decrease in gut motility due to dehydration and shunting of blood from the splanchnic vascular bed. Hypoglycemia, pain, hypothermia, and electrolyte derangements can also contribute to the development of secondary gastrointestinal ileus. Before initiating enteral support, these characteristics should be assessed and abnormalities corrected to the extent that the situation permits.

**Step 2: Assessing the SSB Reflex**

The foal’s ability to execute a coordinated (SSB) reflex and self-feed should also be evaluated. This process assists in defining the extent to which the foal’s ability to nurse is compromised and serves as baseline to which the results of future assessments can be compared. Specific methods for assessing the SSB reflex in foals are not described in the literature, but some guidelines can be modified from human medicine, in which this capacity is closely monitored in sick or premature neonates. These recommendations are shown in Table 2.

| Table 2. Suckle-Swallow-Breathing Reflex Assessment in the Neonatal Foal |
|-----------------------------|-----------------------------|
| Function | Assessment |
| Suckle | Observe the foal’s attempt to nurse to determine if it can find the teat, latch well, and achieve a nutritive suckle. |
| | Place a nipple and observe suckle strength, tongue position, and movement. Appraise how well the tongue “curls” around the nipple. |
| | Place a clean moist digit in the foal’s mouth and “feel” for a strong anterior to posterior wave along the length of the palpable tongue. The wave should center the digit and compress it against the palate. |
| Swallow | Observe the foal as it suckles to be certain that it remains latched for 20 to 30 seconds at a time, swallows, and does not lose milk out of the mouth. |
| | Observe if the foal moves from one teat to the other and if the udder is significantly drained by the end of the suckle period. |
| | Auscultate the foal’s trachea as it is suckling to confirm it is swallowing and that there is no liquid in the trachea. |
| | Observe the foal after suckling for the presence of milk in the nostrils. |
| | Palpate and visualize the palate to be certain it is fully developed, especially if milk is observed in the nares. |
| | If palate defect is suspected, confirm by upper airway endoscopy. |
| | If aspiration is a concern, place 3 to 4 ounces of water in the anterior portion of the foal’s mouth while the endoscope is in place and observe if the water is moved to the posterior mouth and swallowed. |
| Respiratory | Auscultate the foal as it suckles to detect any fluid entering the trachea. |
| | Observe the breathing pattern of the foal while sucking to determine if the animal has prolonged apnea immediately after swallowing. |

*Some foals will lose milk if the mare has a full udder, wide teat, and lets downs well. In these cases, milk loss may be observed early in the suckle period but should be absent toward the end as the udder is emptied.ın-depth: orphan foals—getting a good start in life
This assessment should be performed in the undated foal.

Foals that demonstrate partial or complete dysphagia may not only be at risk for developing aspiration pneumonia. In human infants, dysphagia has been associated with weight loss, poor growth and development, more frequent displays of disorganized (agitated or upset) behavior, poor digestive function, and less efficient tissue oxygenation (possibly due to diminished ability to ventilate efficiently).  

Step 3: Selection, Placement, and Use of the Indwelling Feeding Tube

Access to the neonatal gut is most commonly achieved by placing and securing an indwelling nasogastric feeding tube. Successful use of a tube esophagostomy has also been described in a foal with significant pharyngeal-laryngeal trauma and dysfunction. However, this technique is less applicable to field practice and is not practical in foals that require support for a relatively short period time (less than several weeks). For these reasons, indwelling nasogastric feeding tube selection, placement, and maintenance will be the focus of this discussion.

The use of an indwelling feeding tube to deliver enteral nutrition has been described in the literature as part of the treatment approach in foals with a variety of diseases, including anatomic anomalies such as persistent epiglottic frenulum, congenital esophageal stenosis, or choanal atresia; neonatal maladjustment syndrome or neonatal encephalopathy; and botulism. In a review of 15 cases of full-term septic foals in which enteral feeding was instituted, only one foal demonstrated mild abdominal pain, one refluxed, and three had mild diarrhea. In all cases, these problems resolved with minimal intervention, and 80% of the foals were discharged alive from the hospital. Additionally, failure to survive was not related to complications associated with the feeding tube. The use of indwelling feeding tubes has also been described in other reports of septic foals, illustrating the broad application of this therapy in the management of sick neonates.

A variety of tubes have been used to deliver milk to the stomach of the neonatal foal, including 14F and 16F stallion urinary catheters, red rubber catheter, and small-bore nasogastric tubes. All of these options are adequate for delivery of a single or a few boluses of milk or colostrum, but they can cause significant irritation if maintained in foals for as little as several days. Red rubber catheters, in particular, can also back out of the esophagus and curl in the pharynx, putting the foal at risk for aspiration when milk is delivered through the tube.

Information from human studies performed in the mid-1980s indicate that feeding tubes made of polyurethane are less irritating and less likely to become displaced as compared with tubes made of materials like polyvinylchloride. Feeding tubes made of polyurethane and designed specifically for long-term use in foals are available and have made enteral feeding of the neonate much simpler and safer. The manufacturer has a foal feeding tube that is 108 cm in length, 14F (about 4.7 mm or 0.2 inches) in diameter, and is made of flexible, radiopaque polyurethane so that placement can be confirmed graphically. The oral end has a Y-adaptor to allow dual access to the tube for simultaneous delivery of milk and medication. A wire stylet traverses the tube to provide it rigidity and permit better control of placement. A nasal bracket is also included to help hold the tube in place. The apparatus can be placed in a freezer for 10 to 15 minutes before use to increase rigidity and facilitate passage. In preparation for placing an indwelling feeding tube, the clinician should have the materials listed in Table 3 readily accessible for use during the procedure.

Active foals may require sedation to permit passage of the tube, but sedation depresses the swallow reflex in neonates. Placement of a nasogastric tube can be done in either the standing or down foal. In the standing foal, the process is similar to passing a tube in the adult horse.

If the foal is recumbent, placement of the tube can be more challenging but achievable with some manipulation.

Before passing a tube into a recumbent foal, create a slight bend in the aboral end. Estimate the distance to the larynx to assist with determining when the foal should attempt a swallow or demonstrate a cough. Pass the tube through the “up” nostril with the tip pointed toward the ventral floor of nasal meatus (Fig. 2). Indwelling feeding tubes are flexible and may slip dorsal and into the path of the ethmoid turbinates, so it is helpful to extend a finger deep into the nostril to guide the tube as it passes along the ventral meatus. Once the phar-
ynx is entered, gently flexing the foal’s head assists in positioning the tube so that it tracts along the peak of the pharyngeal arch, above the arytenoids and trachea, and toward the upper esophageal sphincter. As the tube approaches this area, gently rotate the tip so it is oriented toward the upper third of the larynx. The swallow reflex can be dull or absent in sick or stuporous foals, and the cough reflex may be absent or diminished even in normal neonatal animals. These factors make it difficult to know when the tube is correctly oriented to enter the esophagus and is the reason for estimating the distance to the larynx before the tube is passed.

A soft resistance is felt when trying to advance if the tube is in the correct position against the larynx. If the resistance is nonyielding, the tube tip could be lodged in the pharyngeal recess located dorsally and slightly rostral to the larynx. To reposition the tube, retract it a couple of inches and reduce the angle of flexion of the foal’s head so that the tube drops below the recess and tracks caudal into the area of the larynx. Once the tube is in position, manipulate the larynx by external maneuvering, blowing a burst of air into the tube, or delivering a small volume of cool water into the foal’s mouth to induce a swallow. During this process, apply gentle pressure to the tube so that it advances any time that the foal swallows. If the foal does not swallow, administer couple of gentle taps to the larynx with the end of the tube, but use this approach judiciously to avoid causing any trauma to the foal’s pharynx or larynx. Rotating the tube or reducing restraint on the foal can also occasionally elicit a swallow.

If a swallow cannot be provoked, attempt to advance the tube directly into the esophagus. This is done by gently positioning the tube adjacent to the larynx and blowing air through the tube while applying slight pressure to advance. When the tube enters the esophagus, a slight drop in the pressure will be noticed. To confirm the position, apply gentle suction on the external end of the tube. If the tube is in the esophagus, the suction causes negative pressure when the flaccid esophageal tissue draws into the end of the tube and limits the amount of air that can be withdrawn.

As the tube is advanced down the esophagus, it should be visible and palpable on the left side of the neck. If air is blown into the tube, the escaping gas is audible with a stethoscope and also palpable. Do not rely on the absence of a cough as evidence that the tube is in the esophagus, because sick neonates may have a very delayed or absent cough reflex. Once the tube enters the stomach, retrieve a sample of gastric contents. Examine the sample closely to confirm that it is derived from the stomach, because secretions from the stomach of an unfed foal can appear similar to secretions from the foal’s airways. If the position of the tube cannot be established with certainty, a radiograph that captures the cervical region and cranial thorax will confirm placement. When viewing the radiograph, track the entire length, since the esophagus will overlay the trachea along some parts of the neck, giving the false impression that the tube is in the trachea. Likewise, placement of the tube can be confirmed by endoscopic visualization of the laryngeal region. This approach allows the assessment of the pharynx and larynx as well as the trachea (if aspiration is suspected) before initiating feeding.

### Table 3. Supply List for Passing and Securing an Indwelling Nasogastric Feeding Tube

<table>
<thead>
<tr>
<th>Material</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-Y Jelly</td>
<td>Lubricate tube</td>
</tr>
<tr>
<td>60-mL syringes filled with cool clean water if needed</td>
<td>Stimulate swallow and check tube placement</td>
</tr>
<tr>
<td>60-mL syringe filled with air</td>
<td>Evacuate water from the tube</td>
</tr>
<tr>
<td>Tape butterfly</td>
<td>Attach to tube and suture to nostril</td>
</tr>
<tr>
<td>Indelible marker</td>
<td>Mark tube once it is in place</td>
</tr>
<tr>
<td>Dry 4 × 4 gauze (clean but not sterile)</td>
<td>Dry tube and nostril before applying butterfly</td>
</tr>
<tr>
<td>2–0 Nonabsorbable suture on a straight cutting needle</td>
<td>Suture butterfly or Chinese finger trap to nostril</td>
</tr>
<tr>
<td>2-Inch flexible, conforming tape</td>
<td>First layer of wrap around the feeding tube</td>
</tr>
<tr>
<td>3-Inch flexible, adhesive tape</td>
<td>Final layer of wrap around tube</td>
</tr>
<tr>
<td>Towel</td>
<td>Wipe hands and foal’s nostrils as needed throughout the procedure</td>
</tr>
</tbody>
</table>

Fig. 2. In recumbent foals, pass the nasogastric tube in the “up” nostril.
Once the position is confirmed, the tube can remain in the stomach or be retracted to the level of the distal esophagus. Some clinicians prefer the tube placed to the level of the distal esophagus to reduce the risk of milk tracking out of the stomach, up the esophagus, and causing aspiration. Others prefer placing the tube into the stomach so that the foal can be checked for reflux before each feeding. The feeding tubes that are currently available are of small diameter and flexible, and these qualities reduce the risk of reflux through the distal esophageal sphincter if the tube end is in the stomach. Likewise, difficulties associated with delayed gastric emptying can be avoided by careful evaluation of the foal for evidence of increased abdominal distention or discomfort, so the decision of where to place the tube is mainly based on clinician's preference.

When the tube is in position, the stylet is withdrawn. Infusion of a small amount of water through the tube facilitates smooth withdrawal of the stylet. Once out, infuse 60 mL of warm water, followed by air, to make sure the tube is patent and the foal does not have any discomfort when material is delivered through it. If there is a need to feed the stylet back into the tube, do not do this while it is in the foal. The stylet can penetrate the wall of the tube, especially if it is bent or damaged, and may continue on through the wall of the esophagus.

After the stylet is removed and the patency is confirmed, the tube is dried and marked at the point where it enters the nostril to serve as a record of how far it is in the foal. The tube is then secured in place, using a tape butterfly or a Chinese finger trap. When using a butterfly, the “wings” are positioned flat against the mucosal side of the nostril. The first pass of the needle enters through the external (skin) side of the nostril and exits through the mucosal side. The needle then takes a large bite of the butterfly and is directed through the nostril from the mucosal side back to the skin side. The suture is tied on the skin side, and a second suture is placed in the same sequence on the other side of the tube. As an alternative, a Chinese finger trap is initiated by placing a large single suture through the nares with the loose ends facing the inside of the nostril. A square knot is placed in the suture on the “nostril” side. The suture is then brought around the tube and secured with a square knot. Once the tube is secured with a single throw, it is then woven back and forth down the tube, with a single throw placed at every 180° for 6 to 8 weaves. After the final throw, the suture is tied in place using a square knot. If the tube is pulled in the oral direction, the suture is then brought around the tube and secured with a single throw, it is then woven back and forth down the tube, with a single throw placed at every 180° for 6 to 8 weaves. After the final throw, the suture is tied in place using a square knot.

Once in place, the free end of the tube is secured on the foal’s muzzle by creating a curve in the tube and bringing the free end along the foal’s jaw line. The free tube is secured in place with tape. The layers closest to the skin are covered with one or two passes of an elastic, self-adhering, conforming tape, which will not hold the tube in place but serves to reduce the amount of contact between the foal’s skin and the next layer. A second layer of a stretchable, adherent tape is applied. This tape holds the tube in place and should extend beyond the rostral and caudal borders of the first tape layer so that it adheres directly to the foal. When applying either layer, the tape should be unwrapped and laid on the muzzle without tension so as not to place pressure on the foal’s jaw and prevent it from being able to open its mouth. Foals can suckle with the tube in place as long as the wrap is not too constricting (Fig. 3).

The Mila feeding tube is designed so that the length can be adjusted. This eliminates the need to wrap up the free end along the foal’s jaw. However, if the free end of the tube dangles excessively, this can be irritating for the foal. Rarely, foals step on the free end (especially if the tube has partially slipped out of the foal without notice) and pull the tube from their nostril. For the foal that exces-sively rubs out its tube, application of a soft muzzle after the tube has been placed often reduces the foal’s success in future attempts to remove the tube.

When removing the tube tape, do so carefully by pulling the tape in the direction of the hair. Application of a solvent such as acetone can reduce epilation of the area, but if the foal’s skin is already chapped or damaged, these chemicals can be very irritating. In many cases, the tape will come off with gentle pressure. However, if the foal’s skin begins to detach or if epilation is excessive, sedate the animal to prevent sudden jerking and slowly retract the tape while supporting the skin with digital pressure.

Additional problems that can be encountered when passing a feeding tube include traumatic hemorrhage from injury to the ethmoids, pharyngolaryn-
geal trauma, malposition of the tube, and rhinitis. Ethmoid hemorrhage is recognized as a complication of nasogastric intubation in all age groups and rarely causes any long-term risk to the foal's health. Foals that are highly agitated by the intubation can exhibit prolonged periods of hemorrhage due to elevated blood pressure associated with stress. If the foal's head position is low relative to the heart, this can contribute to prolonged bleeding. Foals experiencing disseminated intravascular coagulopathy (DIC) or thrombocytopenia may also hemorrhage excessively.

Trauma to the pharynx and larynx can occur when a larger-bore, hard tube is used in the foal. The risk of irritating the foal's tissues is also increased when a tube of this nature is kept in place for several days. Indwelling feeding tubes designed for foals tend to be well tolerated, nonirritating, and have been reported to be in place for up to 3 weeks without inducing significant trauma. The cost of these tubes is about $30.00, and in some cases they can be sterilized and reused.

Occasionally feeding tubes may become malpositioned while being passed. Due to the soft, flexible nature of the tube, it can fold back on itself, spiral around the pharynx, exit out the opposing nostril, or drop below the soft palate into the oral cavity during placement. Excessive gagging or chewing by the foal while the tube is being advanced is evidence that the tube is malpositioned. When these signs are observed, withdraw the tube and start the procedure anew.

Step 4: Preparing the Mare’s Milk or Milk Replacer
Feeding options are discussed in other lectures in this series and will not be repeated here. Instead, proper handling of the foal's diet will be described because the method of preparation can influence nutritional value, freshness, and bacterial content.

Although food entering the gut is not sterile, it is important to maintain cleanliness and not overburden the neonatal gut with a high dose of bacteria. To avoid this, the area in which the foal's diet is prepared should be "kitchen" clean. When feeding mare's milk, empty the udder every 2 to 4 hours and strain the milk through several layers of gauze to remove large debris. Set aside the volume required for the current meal and place any additional milk in the refrigerator. Label containers of milk with the date and time of collection, and only use milk that is less than a day old (fresher if possible). When reheating mare's milk, warm only the volume required for each feeding. Use warm water, and be certain to mix the product well. Withdraw the amount required for the current feeding and refrigerate the rest in a clean, covered container that is labeled with the date and time. As with mare's milk, remove only the volume required for each feeding, heat slowly, and discard any unfed replacer when feeding is complete.

Neonatal foals in which gastrointestinal motility is compromised are at risk for bacterial overgrowth in the gut. In addition, gastro-protectants that minimize the formation of stomach ulcers by blocking gastric acid secretion also block the sterilizing effect of acid pH in the stomach. This permits bacteria in the ingesta to survive and pass into the small intestine, increasing the risk of bacterial overgrowth and enteritis. For these reasons, it is important to thoroughly clean all supplies between every feeding. This includes mixing bowls, dose syringes, milk containers, and any other material that comes in contact with the foal's food. Milk and milk replacer products should always be refrigerated until used, and they should be discarded after 1 day. If the milk or replacer separates or smells sour, discard it and start fresh. Foals being fed through a feeding tube cannot reject milk or replacer that has soured, so it is important for the caregiver to be vigilant in identifying and discarding spoiled food.

Step 5: Managing an Indwelling Feeding Tube
Although there are fewer risks associated with enteral feeding as compared with parenteral feeding, significant problems can arise when feeding tubes are not managed properly. To minimize risks, it is beneficial to have a detailed description of the feeding procedure and to encourage all personnel working with the foals to follow these steps so that the process becomes routine. Having this information written out and readily accessible also helps to establish a routine method for handling and delivering the foal's food (Appendix 1).

Before delivering milk, the foal should be standing or placed in a sternal position with the head elevated above the level of the stomach to reduce the risk of milk refluxing up the esophagus and into the lungs. The tube should be cleared with air to make sure it is patent, followed by an attempt to withdraw fluid from the stomach. If more than 40 mL of milk or putrid reflux is obtained, consider feeding the foal a reduced volume for this meal or withholding food for an additional 1 or 2 hours. If reflux persists for 2 or more feedings (4 hours), parenteral nutritional support may be indicated to allow the gut a period of rest. In addition, carefully assess the foal for evidence of brewing clostridial enteritis (cold extremities, dark mucous membrane color with delayed refill, bloating, displays of abdominal pain and distention, increased restlessness) and add metronidazole to the foal's treatment if this infection is suspected.

If minimal reflux is retrieved, flush the tube with 20 to 30 mL of water and observe the foal for evidence of coughing or nasal discharge. If either is
observed, or fluid is auscultated in the airways, stop and check the tube position. If the position cannot be confirmed, withdraw and replace the tube.

Milk or replacer can be delivered through a funnel, dose syringe, or feeding bag. Feeding bags are the preferred method of delivery because the milk or replacer is minimally exposed to the barn environment while being fed. In addition, the food is delivered by gravity, which reduces the risk of overfilling the animal’s stomach (Fig. 4). If a bag is used, it must be cleaned between each feeding and hung in a manner that maximizes drainage and drying. After the milk is delivered, flush the tube with 20 to 30 mL of clean water, followed by 20 to 30 mL of air to purge the tube of any residual liquid. Clean the end of the tube and cap it.

Step 6: Initiating Enteral Nutrition
As described earlier, derangements of hydration status, electrolytes concentrations, and acid-base status should be corrected before initiating delivery of enteral nutrition. This is not always possible in sick foals, especially in a field environment. Foals also do not have adequate energy stores to delay institution of support while all deficits are corrected. Consequently, close monitoring is essential to prevent complications that can exacerbate the foal’s clinical problems.

The daily milk consumption of a young healthy foal is equivalent to as much as 27% of its body weight. In these cases, IV administration of simple parenteral nutritional support using dextrose-containing solutions, serves as a bridge to more long-term enteral support. In humans, it is common for sick neonates to have gut ischemia in conjunction with hypoxia, septic shock, and dehydration, and such insults affect gut motility. Foals have the additional risk of severe gastric dilation and rupture. Consequently, a conservative approach is advised when deciding the initial volume of milk/replacer to initially provide a sick foal.

In most cases, sick foals can tolerate 5% to 10% of their body weight in daily volume divided over 12 (every other hour) feedings. For a 50-kg foal, this equates to 415 mL of milk/replacer every 2 hours, for a daily total of 5 liters per day. Mare’s milk contains about 0.5 kcal digestible energy (DE/mL) on an as-fed basis and provides 2500 kcal/day to a 50-kg foal. The normal 50-kg neonatal foal requires roughly 120 to 159 kcal DE/kg body weight per day (6000 to 8000 kcal total), but the needs of the sick neonatal foal, when measured by indirect calorimetry, have been shown to be reduced to 45 kcal DE/kg body weight. Based on these findings, providing 10% of the foal’s body weight in milk meets the needs of a sick neonate. As the animal’s condition stabilizes, increase the volume every 12 to 24 hours by 5% until a daily volume of 20% to 25% of the body weight in kilograms is achieved. In a 50-kg foal, this is equal to about 1 liter every 2 hours, for a total of about 12 liters per day. For premature neonates, even small amounts of milk (25 to 50 mL/hour for a 40-kg foal) fed on a frequent basis can be beneficial, since the gut epithelium derives nutrients from luminal contents. In these cases, additional support in the form of parenteral nutrition will be required to meet the animal’s energy needs.

6. Complications Associated With Indwelling Enteral Feeding Tubes
The primary complications associated with enteral feeding include malposition of the tube, laryngopharyngeal trauma, aspiration, overfeeding, bloating, diarrhea, and colic. Foals also develop rhinitis secondary to the placement of the tube, but this is usually a self-limiting condition that does not require significant medical intervention.

Malposition can occur after the tube has been in place several days to weeks. The cause is rarely due to spontaneous tube failure and is more frequently associated with efforts on the foal’s part to remove the tube. If the tube backs partly into the pharynx, it can spiral around that space, back into the opposing nostril, or drop down into the oral cavity, where it may be bitten off. The tube can also slide part way out of the nares. For this reason, it is important to check the position before each feeding and to replace the tube if there is any suspicion that it is not in the esophagus.

Use of large-bore and/or stiff tubes can cause significant laryngopharyngeal trauma to horses of all...
In one report, a 285-gestational-day-old, premature foal was provided milk by an indwelling nasogastric tube from day 26 until day 51 of age, and endoscopic examination on day 100 revealed that the esophagus was healed with no apparent defect on the mucosal side, and only a small, palpable defect in the musculature from the skin side of the esophagus was noted.34

Follow-up out to 36 months revealed that the esophagus was healed with no apparent defect on the mucosal side, and only a small, palpable defect in the musculature from the skin side of the esophagus was noted.34

Aspiration may occur in foals even when the tube is properly placed. Large-bore and/or stiff tubes passed into the stomach dilate the distal esophageal sphincter, facilitating gastroesophageal reflux. Recumbent and stuporous foals can have a poor cough response and esophageal tone, further facilitating the aspiration of the food that has backtracked up the esophagus. Placement of the end of large-bore tubes in the esophagus, or use of small-bore tubes, minimizes regurgitation and decrease the risk of aspiration. In addition, maintaining the level of the foal's head above the stomach reduces the risk of gastroesophageal reflux and aspiration.

Recent studies of critically ill humans have provided evidence that overfeeding (exceeding the caloric needs) of sick adults and neonatal patients increases their risk of developing metabolic imbalances such as hyperglycemia, hypercapnea, and azotemia and causes injury to other major organs. Sick human infants have been shown to require less than 50% of the kilocalories as normal infants, and this pattern also appears to be true for foals. Sick human infants have been shown to require less than 50% of the kilocalories as normal infants, and this pattern also appears to be true for foals. Blood glucose, triglyceride, and electrolyte concentrations should be monitored on a regular basis (Table 4) to assist in detecting evidence of overfeeding or intolerance of the diet, and the dietary composition should be altered or supplemented to meet the needs of the foal.

Hyperglycemia is commonly observed in sick foals when enteral or parenteral feeding is initiated and can be a sign that initial feeding is too aggressive. Reducing the volume of feed by 50% for several feedings and allowing the foal to stabilize is often all that is required to establish normoglycemia. Occasionally, sick foals demonstrate a persisting hyperglycemia. In such cases, insulin can be administered. The recommended dose is 0.1 to 0.5 IU/kg given SC or IV. When administering insulin, monitor blood glucose frequently (see Table 4) to make sure that the foal does not become hypoglycemic. Methods for providing continuous insulin infusion have been described elsewhere.
continuous infusion requires close monitoring and is impractical in the field.

As previously discussed, gastric motility may be delayed or absent in sick foals, resulting in bloating and/or colic. The foal's small intestine does not tolerate distention, and, when intraluminal pressures exceed about 25 mm Hg, capillary beds within the intestinal wall collapse, resulting in poor tissue perfusion and injury. The foal should be evaluated for abdominal bloating before each feeding. This can be accomplished by marking an area on the foal's abdomen and measuring the diameter, using a tape or string. If diameter size increases over several consecutive feedings, further evaluation is warranted. Ultrasound examination of the foal's gastrointestinal tract permits a better estimate of small intestinal and gastrointestinal distention and motility. If bloating is suspected, an attempt should be made to reﬂux the foal. The small-bore feeding tube should be removed from the foal and replaced with a larger-bore tube (such as a stallion catheter or small adult nasogastric tube) to facilitate effective lavage and retrieval of fluid in the gastrointestinal tract. Enteral feeding is suspended for 2 to 4 hours or until the distention resolves. Feeding is then reinstituted at a smaller volume. If the foal requires a longer period of gut rest, parenteral nutritional support may be required to maintain the foal until the gut becomes more tolerant of enteral nutrition.

Diarrhea or constipation occurs in foals receiving enteral nutrition and may be related to the diet composition and quality and/or disease state and activity level of the foal. Foals have diarrhea when the milk or replacer is soured, contains high concentrations of bacteria, or is too concentrated. Cleaning the equipment well between feedings and making sure only fresh, clean milk is fed to the foal reduces this risk. When commercial milk replacer is fed, it is important to check the osmolality of the product. If it is greater than 300 mOsmol, diluting the replacer by 50% may resolve the problem. Remember that diluting the replacer also reduces the calories per milliliter by the same percentage, so the amount that the foal is fed will need to be gradually increased to meet its energy needs. The addition of human products (such as LACTAID®) designed to improve digestion of the milk sugar lactose may assist in reducing diarrhea, but lactose intolerance is not a proven syndrome in foals.

Gastrointestinal motility can also be delayed in sick neonates, placing them at risk for constipation. Low activity levels, coupled with inadequate water intake, can also affect fecal consistency and transit time, resulting in constipation. If fecal consistency is harder than normal, confirm that the foal is receiving adequate amounts of water by either the parenteral or enteral route. Normal foals require about 100 mL/kg/day of water to meet maintenance requirements, and that amount is increased in dehydrated foals or animals with ongoing losses. Checking urine specific gravity and adjusting fluid intake to maintain a specific gravity <1.015 is a simple way to estimate the foal's hydration status. When constipation occurs, warm enemas composed of mineral oil and water administered by gravity will soften feces in the rectum but should not be administered more than a few times per day to avoid irritating the mucosa of the bowel. Mineral oil can also be administered through the nasogastric tube. In recumbent foals, provide several small doses (60 mL per dose) through the tube over a 12- to 24-hour period rather than one large dose to avoid overfilling the stomach, causing reflux and aspiration of the oil. Do not administer mineral oil by dose syringe, because it has little flavor or texture and is therefore easily aspirated. Pneumonia resulting from mineral oil aspiration can be especially difficult to treat and should be avoided.

When the tube has been in place for several days, the foal can develop a mucoid nasal discharge from the nostril in which it dwells. Typically this is due to a local rhinitis that occurs in response to the presence of the tube. If the foal has rubbed or made other attempts to remove the apparatus, the risk of rhinitis is increased. The rhinitis may persist for several days to several weeks after the tube is withdrawn but rarely requires specific treatment. It is not associated with significant systemic illness, and if fever, lethargy, anorexia, or other signs of disease are observed in conjunction with the presence of discharge, conduct a complete examination of the foal to rule out other causes.

Occasionally foals have development of persisting dysphagia. In humans, dysphagia is a common problem in premature neonates less than 28 weeks of gestation age. Foals that are born with a strong suckle but loose that suckle as they become ill tend to recover the ability as their disease resolves. However, premature foals that require an indwelling feeding tube from birth can require several weeks or longer to establish an effective suckle. In human premature neonates, development of the suckle-swallow response is promoted through manipulation and positioning of the mouth and oral cavity and stimulation with a pacifier. Further studies are required to determine if these types of exercises could benefit the dysphagic foal.

Appendix 1

Client/Technician Instructions for Feeding Through an Indwelling Tube

Required materials include:

- 60-mL air-filled syringe
- 60-mL warm water–filled syringe
- Additional water in clean container
- Empty 60-mL syringe
- Milk feeding bag
- Gauze 4 × 4 pad or paper towel
- Alcohol
1. Positioning the foal: Foals can be fed while standing or down. If the foal is recumbent, place it on its sternum with the head elevated above the level of the stomach.

2. Measure the diameter of the abdomen and record. If the abdominal diameter has increased for three feedings in a row, closely examine the foal for any signs of discomfort. If the abdomen is otherwise normal, then feed half the volume of milk and re-check in 1 to 2 hours. If the abdomen continues to distend, immediately contact the clinician in charge of the case before continuing.

3. Look for the mark on the tube that signifies where it entered the nares to make sure that the tube has not backed out of the foal. Clean off the feeding tube port with water or alcohol and open.

4. Inject 20 to 30 mL of air to check for patency. Gently pull back on the syringe to check for reflux. Withdraw fluid and air until none remains.

5. If more than 40 mL of fluid is retrieved, and/or the fluid is putrid or hemorrhagic, flush the feeding tube with a small amount of water and withhold feed for 1 to 2 hours. If the foal has refluxed for more than two feedings in a row, immediately contact the clinician in charge of the case before continuing.

6. If there is less than 40 mL of fluid retrieved, proceed to the next step.

7. If resistance is not felt, then discontinue feeding by gavage and encourage oral intake.

8. If there is resistance or the foal coughs, stop and check tube position.

9. Attach the feeding bag tubing to the indwelling feeding tube and allow bag to empty by gravity.

10. Check in 1 to 2 hours. If the abdomen continues to increase in diameter, detach and flush the feeding tube with a small amount of water and withhold feed for 1 to 2 hours. If the foal is recumbent, place it on its sternum with the head elevated above the level of the stomach.

11. If more than 40 mL of fluid is retrieved, and/or the fluid is putrid or hemorrhagic, flush the feeding tube with a small amount of water and withhold feed for 1 to 2 hours. If the foal has refluxed for more than two feedings in a row, immediately contact the clinician in charge of the case before continuing.

12. Clean the end of the tube, flush it clear with a small amount of water (20 to 30 mL), and cap.

References and Footnotes


33. Biron M, Da Nobrega L, Roux S, et al. Effects of oral stimulation and oral support on non-nutritive sucking and...


*3M™ Vetrap™ Conforming Tape, 3M, St. Paul, MN 55144-1000.

*Elastikon Tape, Johnson & Johnson Company, New Brunswick, NJ 08933.

2012 / Vol. 58 / AAEP PROCEEDINGS