Small ruminants for the bovine practitioner

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Abstract
The increase in small ruminants raised on hobby farms as well as the increase in large scale sheep and goat operations in the United States represents a potential opportunity for bovine practitioners to expand their practice into these fields. Provision of herd health services by veterinarians to sheep and goat clients has traditionally been less frequent than with cattle producers, but can provide value to the producer, particularly with increased practitioner awareness of species-specific differences in production and management practices. In addition, while sheep and goats share many of the same common medical and surgical conditions as cattle, these conditions often differ in their clinical presentation, diagnosis and treatment. Knowledge of these differences can assist the bovine practitioner in confidently serving this emerging market of livestock producers.

Key words: sheep, goats, herd health, small ruminant medicine

Introduction
In most cases, the formative education of veterinarians in the health and management of ruminant species is heavily focused on cattle with little emphasis in core curriculums on small ruminant medicine. However, bovine practitioners may find that there is a need for veterinary care of these species in their practice area which is currently underserved. Many of the skills necessary to successfully serve these clients have already been mastered by bovine practitioners. Small ruminant clients ideally require similar herd health services as cattle clients, including pregnancy diagnosis as well as development of treatment and vaccination protocols, but the provision of these services offers some unique challenges. While sheep and goats, as ruminants, share many of the same common medical and surgical conditions as cattle, these conditions often differ in their clinical presentation, diagnosis and treatment. Certain diseases are also unique to these species, and knowledge of these differences is critical to providing high-quality care. Improved knowledge of these differences can assist the bovine practitioner in confidently serving this emerging market of livestock producers. A brief overview of select topics associated with providing general practice services to small ruminant clients is provided; for more in-depth information on the topics provided, practitioners are highly encouraged to utilize the references list for a selection of highly useful books and articles related to small ruminant practice.

General tips and tricks
Most of the tools and medications necessary to successfully treat small ruminants and camelids are already readily available to bovine practitioners. It is important to keep in mind, however, that there are very few medications that are labeled for use in small ruminants, and extralabel drug use is a frequent necessity. For an in-depth discussion of legal and illegal drug use in small ruminants, and antimicrobial stewardship in small ruminant practice, practitioners are referred to other proceedings from this conference. For some medications that do not allow extralabel drug use in any food producing animal, such as the fluoroquinolones, use is strictly prohibited in sheep and goats because there are no labeled products in these species. Withdrawal time is also an important consideration in any decision to utilize medications in an extralabel manner. Practitioners are strongly encouraged to utilize FARAD to establish appropriate withdrawal times in these species.[8] Because there are no safe tolerance levels set for many medications in small ruminants, any level of drug detected would be considered a residue violation. This means that substantially increased recommended withdrawal times may be necessary in some cases compared to those allowable in cattle. Of particular note, the use of camelids as meat animals in the U.S. has also increased over the last decade, therefore, care should be taken when prescribing medications for these animals to ensure that producers are aware that if the animals are being harvested for meat, appropriate withdrawal times must be established for all medications (even those over-the-counter such as anthelmintics).

Not all medications are tolerated as well in small ruminants as in cattle. For example, the larger body mass of cattle allows utilization of lidocaine for routine procedures without fear of toxicity; however, the much smaller body mass of small ruminants makes lidocaine toxicity (which can occur at dosages >2.75-4.5 mg/lb [>6-10 mg/kg]) a significant concern. Dilution of 2% lidocaine 1:1 with sterile water immediately prior to use is helpful to decrease the risk of toxicity.[19] Small ruminants are also very sensitive to the sedative effects of xylazine, and very low dosages are recommended (0.005-0.02 mg/lb [0.01-0.05 mg/kg] IV). Practitioners wishing to utilize xylazine for sedation of small ruminants and camelids should carry the 20 mg/mL formulation, and dilution to a 1-2 mg/mL solution using sterile water is highly recommended to avoid dosing errors.[19] Care should also be taken when utilizing reversal agents such as tolazoline or yohimbine as rapid IV administration can lead to significant respiratory effects. Differences also exist between sheep and goats themselves in the safety and efficacy of medications. While tilmicosin is labeled for use in sheep for treatment of respiratory disease, it should not be used in goats as it has been shown to cause fatal reactions. The half-life of many drugs that undergo hepatic metabolism also differ greatly between sheep and goats. Due to this difference, recommended dosing of anthelmintics in goats is generally 1.5 times (levamisole) to 2.0 times (benzimidazoles, avermectins) the ovine anthelmintic dose.[1]

Herd health services
Herd health services are the primary mechanism for income in many bovine practices and similar services can be offered to small ruminant clients as well. Pregnancy diagnosis via transabdominal ultrasound to stage pregnancies and count the number of fetuses is a key tool in prevention of pregnancy toxemia (which will be discussed later) as it allows for improved feeding management of groups of animals.[5] While a standard linear rectal probe can be utilized for very early transrectal diagnosis or an attempt at a transabdominal pregnant/open determination, a curvilinear ultrasound probe with a lower frequency (3.5-5.0 MHz) is needed to adequately stage and perform fetal counting. It is important to note that the presence of uterine fluid is not by itself a positive sign of pregnancy in small ruminants due to a high incidence of hydrometra; visualization of

fetal structures is necessary to confirm a pregnancy diagnosis in these species. Transabdominal ultrasound from 45 to 85 days of age provides the most accurate window for both positive identification of pregnancy as well as fetal counting and staging, particularly for practitioners who don't perform this service on a regular basis. Routine monthly herd checks starting at 45 to 60 days after the beginning of the breeding season and ending 45 days after the end of breeding season allows for pregnancy confirmation, fetal counting, as well as accurate staging of pregnancies to best manage flocks based on number of offspring and anticipated birthing window.[7,22]

Design of vaccination schedules for small ruminants and camelids is often simplified compared to cattle due to the overall decreased number of available labeled vaccines.[13] All small ruminants should receive an initial 2-dose series of a clostridial vaccine containing at minimum *Clostridium perfringens* C and D plus tetanus toxoid with a yearly booster; for pregnant females, this booster should be 3-4 weeks pre-parturition to enable adequate passive transfer of immunity to offspring. Seven-way or 8-way clostridial combination products are also available and may be utilized in herds with a history of disease caused by other clostridial species. If multivalent clostridial vaccines are selected, care should be taken to ensure the vaccine contains a tetanus toxoid. In breeding herds or flocks, the use of reproductive vaccines against Campylobacter jejuni/C. fetus subsp. fetus and Chlamydophila abortus can be beneficial in preventing abortion storms. Routine use of in-feed oxytetracycline has been historically used for prevention of these abortions in sheep and goats. With the recent emergence of a tetracycline-resistant clone of C. jejuni as the predominant cause of Campylobacter associated abortion in sheep [17], this practice is no longer considered as effective and is complicated by the necessity for a VFD. In herds or flocks with a history of contagious diseases such as caseous lymphadenitis or contagious ecthyma, or in areas of the country with a significant history of Bluetongue virus or anthrax, incorporation of vaccinations may decrease the economic impact of these diseases to the herd or flock. Milking herds may also benefit from vaccines targeted to mastitis pathogens, including the newly approved product targeting staphylococcal mastitis, the primary cause of subclinical mastitis in small ruminants.[15]

While it may be tempting to incorporate extralabel bovine vaccines in small ruminant protocols, it is important to keep in mind that many of the causative agents of infectious diseases that present with similar clinical signs differ between species. For example, keratoconjunctivitis in sheep and goats is primarily caused by Mycoplasma or Chlamydia species; bovine vaccines targeting Moraxella species are ineffective. Foot rot, which is highly contagious and a disease of the horn in sheep and goats rather that the soft tissue of the foot as in cattle, is caused by Dichelobacter nodosus; vaccination for bovine foot rot caused by Fusobacterium necrophorum is not effective for this condition. The agents of respiratory disease in sheep and goats also differ from those found in cattle; while most cattle isolates of Mannheimia haemolytica are type A1, type A2 has been isolated most commonly from goats and sheep. Cross-reactivity among strains is variable, therefore, while a combination killed bacterin of M. haemolytica and Pasteurella multocida is labeled for sheep and goats, most vaccine strains of these organisms are derived from bovine isolates and the efficacy of these vaccines in small ruminants is inconsistent.[23] Respiratory viruses of small ruminants are also antigenically different from similar herpes, parainfluenzaand respiratory syncytial viruses in cattle. While intranasal modified-live viral respiratory disease vaccines from cattle have been anecdotally used in an attempt to control pneumonia in sheep and goats, the only recently published study on this topic did not show success at pneumonia prevention with this practice.[21]

Sheep and goat producers, particularly small hobby farms, may also benefit from assistance with several typical processing procedures, including foot trimming, disbudding and castration. Routine foot trims are a necessity in sheep and goat operations due to the constant growth of the horn wall and can be performed with the purchase of trimming shears or electric trimmers. Disbudding is ideally performed within the first few weeks of life; current research suggests that cautery dehorning remains the preferred approach.[4,9,20] Dehorning at a later date requires sedation/anesthesia and surgical removal of the horn and base with primary closure of the dehorning site[12]; therefore, every effort should be made to perform disbudding at an earlier age. Due to comparatively thin skulls, extreme caution should also be taken to avoid over-cauterization of horn buds which can lead to thermal injury of the brain and sudden death up to several days after the procedure.[11] Multi-site (2 or 4) or ring cornual blocks rather than single-site injections as in cattle are necessary to decrease sensation to the horn bud. Recent research, however, has shown that the act of blocking may be just as painful as the disbudding procedure itself, and further research is needed to determine best approaches for pain mitigation of this procedure.[2,10] Recommended timing of castration also differs depending on the intended use of the animal. From a pain perspective, early castration around the time of birth via banding for animals destined for meat production likely provides the best mitigation of pain responses to this procedure. Testicular development in small ruminants is rapid compared to overall body size, therefore, banding of older animals quickly becomes problematic, particularly due to a high susceptibility to tetanus. For animals destined to be pets, research suggest that delaying castration until 3 months of age may be beneficial in increasing urethral diameter, potentially decreasing the risk of obstructive urolithiasis.[3] In these animals, surgical castration under sedation is preferred to banding.

Key medical conditions shared between cattle and small ruminants that differ in signalment, diagnosis or treatment

All herd heath discussions with small ruminant producers should also involve discussion of best practices associated with gastrointestinal parasitism and anthelmintic treatment protocols; practitioners are referred to the website of the American Consortium for Small Ruminant Parasite Control for excellent in-depth discussion of this topic[1] Unlike cattle, sheep and goats are highly susceptible to Haemonchus contortus and can rapidly develop severe anemia with moderate worm burdens. Because of this risk, assessment of conjunctival color should be part of the standard physical exam of any small ruminant patient. Whole herd deworming, such as what is still currently practiced in bovine medicine, rapidly leads to loss of refugia (or susceptible worms) and development of anthelmintic resistance on the farm. Veterinarians can serve as valuable resources in training producers to instead utilize FAMACHA scoring, body condition scoring and fecal egg count testing to inform the use of targeted or selective deworming. Development of resistance is farm-specific depending on previous deworming practices; therefore, farm-specific deworming strategies should

be developed based on knowledge of the history of anthelmintics utilized on that farm and fecal egg count reduction testing to determine which anthelmintics retain efficacy. Appropriate dosing of oral (not pour-on or injectable) anthelmintics based on accurate weight and species-specific dosing recommendations is also critical to avoid resistance development; most anthelmintics are labeled for sheep and require increased dosing (as described above) and an extralabel prescription for use in goats. Genetic selection for animals resistant to high worm burdens has been shown to be an effective method for decreasing reliance on anthelmintics; producers should therefore be highly encouraged to cull repeat offenders, particularly animals such as breeding males who contribute substantially to the genetic pool of the herd. Willingness to provide blood transfusion services, which can be accomplished with minimal investment in key supplies, can also be a valuable resource to small ruminant clients struggling with parasitism. Selective treatment of severely affected animals in herds with significant resistance issues may necessitate utilization of a combination of deworming classes simultaneously to achieve adequate reduction in worm burden, but care should be taken to ensure that clients do not utilize this strategy for blanket deworming of the entire herd as this will lead to rapid loss of effectiveness of all available anthelmintics.

Negative energy balance in all ruminants leads to fat mobilization from adipose tissue, lipoprotein deposition in the liver, and production of ketone bodies. In cattle, the most frequently encountered case of negative energy balance is ketosis in the post-calving dairy cow. In contrast, the highest-risk period for negative energy balance in sheep and goats is immediately prior to parturition during the last month of gestation, leading to the condition known as pregnancy toxemia. Pregnancy toxemia is most commonly seen in animals that are either too thin or obese, have >1 fetus, or have another underlying condition leading to decreased feed intake.[5,16] In late gestation, feed intake decreases, particularly in animals carrying multiple fetuses and obese animals due to a lack of free abdominal space, making it difficult to maintain adequate caloric intakes. At the same time, energy requirements for ewes and does carrying twins or triplets are greatly increased over maintenance. Any additional stressors or concurrently illnesses can also precipitate a decrease in feed intake and an increased risk for pregnancy toxemia. Diagnosis of pregnancy toxemia is similar to diagnosis of ketosis in cattle using the handheld β-hydroxybutyrate (BHBA) meter used in dairy cattle. Current research suggests that a cutoff of 0.7 mmol/L is suggestive of hyperketonemia and above 1.0 mmol/L is high risk for significant hyperketonemia in sheep and goats.5,6 Practitioners should be aware that these values are much lower than the recommended cutoff for subclinical ketosis in dairy cattle of >1.2-1.4 mmol/L. Treatment of pregnancy toxemia is typically based on two goals: 1) to provide increased energy sources and 2) to decrease the factors causing the negative energy balance. For mildly affected animals, conservative therapy including provision of oral propylene glycol as an energy source (60 mL PO twice daily) combined with increased provision of high energy feedstuffs, treatment for intestinal parasites, and removal from herd competition situations may be successful.

Alternatively, boluses of 0.1-0.2 mL/lb (0.2-0.4 mL/kg) of 50% dextrose can be administered IV every 4-6 hours, or an infusion of a balanced electrolyte solution with added 5% dextrose (100 mL of 50% dextrose added to each liter of IV fluids) can be administered at a rate of 1-2x maintenance (1-2 mL/lb/hr [2-5mL/kg/hr]). For animals that have become recumbent and are severely affected (i.e. display neurologic signs), immediate induction of parturition or removal of the fetuses via C-section is recommended. Similar to pregnancy toxemia, hypocalcemia in small ruminants is frequently diagnosed prior to parturition, unlike the typical signalment of an immediately post-calving dairy cow. Hypocalcemia may be seen concurrent to pregnancy toxemia; as recumbency is a clinical sign observed in both diseases, differentiation of the two disease processes on farm can be challenging without measurement of blood BHBA and calcium levels. Treatment of uncomplicated hypocalcemia with IV calcium solutions such as 23% calcium gluconate at a dose of 50 mL/100 lb (45 kg) given slowly over 5-10 minutes is typically sufficient to induce rapid improvement in clinical signs. Administration of oral calcium containing pastes as in cattle is not recommended due to risk of overdosing and aspiration/chemical pneumonia in severely affected animals which lack the ability to swallow.

Urolithiasis should be at the top of the differential list for any sick call involving a male small ruminant.[18] Owners frequently report that the animal appears constipated, is vocalizing or posturing abnormally, has gone off-feed, or is dribbling urine; pet wethers are highly prone to this condition due to a smaller urethral diameter, excessive caloric intake and poorly balanced diets. Standard physical examination of any male small ruminant should therefore involve digital rectal palpation to evaluate for pulsatile contractions of the urethra and observation of normal urination; abdominal ultrasound is also very useful to identify an enlarged urinary bladder.

Unlike cattle, male small ruminants possess a urethral process at the end of the penis which has a narrow diameter and is the most likely location for obstruction in these species (closely followed by the sigmoid flexure, which is the primary location in cattle). Because this is the most likely location of obstruction, amputation of the urethral process under sedation is the first step in attempting to relieve urethral obstruction. For many animals, this will alleviate the initial blockage, but further treatment may be necessary to prevent reoccurrence. For animals on a high concentrate diet, struvite uroliths are the most common type of stone seen in cattle, sheep and goats. These stones are degradable under conditions of urinary acidification; therefore, administration of ammonium chloride maybe be beneficial in dissolving stones and preventing reoccurrence. While many commercial diets for small ruminants contain ammonium chloride, the inclusion rate is not high enough to achieve adequate acidification, and similar to dairy cattle, compensation occurs over time leading to decreased efficacy. Pulse feeding of 90-200 mg/lb/d (200-450 mg/kg/d) PO for one week per month is currently recommended for treatment and/or prevention of phosphatic stones in sheep and goats.[14] Failure to resolve obstruction with medical management necessitates surgical intervention. For market animals, a perineal urethrostomy is the treatment of choice in cattle, sheep and goats. For breeding animals or pet small ruminants, this procedure is not recommended as it frequently leads to stricture and re-obstruction. For these animals, a tube cystostomy should be performed, and if that fails, bladder marsupialization or vesiculopreputial anastomosis is an option for pet animals. Calcium carbonate stones, which do not dissolve in acidified urine, are becoming increasingly common in cases of goat urolithiasis and can be incredibly challenging to treat. These stones are radiopaque, and in many referral institutions, it has become common practice to perform radiographs prior to proceeding with surgical

intervention to identify the presence of these stones and provide appropriate guidance on treatment recommendations and prognosis.

Finally, neurologic conditions that affect mentation are also frequently encountered in small ruminant practice. Polioencephalomalacia is a very common diagnosis that may present with a wide array of neurologic signs; the defining feature of this disease is cortical blindness, which is defined as a lack of menace response with intact pupillary light reflexes. In cattle, this disease in commonly associated with sulfur toxicity or grain overload. In small ruminants, an obvious cause for polio is not always present, and even small changes in feed, stress or access to rapidly fermentable carbohydrates in the form of treats can all be antecedent events. Treatment with 4.5 mb/lb (10 mg/kg) thiamine IV or SQ typically leads to improvement in clinical signs within a few hours, with cortical blindness often taking several days to fully resolve.

Along with polioencephalomalacia, sheep and goats are also highly sensitive to development of listeriosis. Mentation changes with evidence of cranial nerve involvement should move listeriosis to the top of the small ruminant neurologic disease differential list. Treatment is the same as in cattle, with high-dose penicillin or oxytetracycline being the medications of choice; however, the published survival rate in small ruminants is much less than that of cattle, making early recognition and treatment prior to recumbency critical to increase the odds of survival.

Conclusion

With a small amount of effort on the part of bovine practitioners, small ruminant herd health, medicine and surgery can be a potential area of increased practice revenue and rewarding cases. Practitioners are highly encouraged to utilize the references provided in these proceedings to obtain further information regarding health management of small ruminants to expand their services into this area.

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