

Treating peri-urban small ruminants

Brandon Fraser, DVM, MS
Diplomate of American College of Veterinary Internal Medicine
Large Animal Clinician
University of Queensland: Gatton Campus
Gatton QLD 4343

Introduction

Small ruminants are increasing in popularity as pets or livestock of choice for small land areas. This is intended to give a variety of tips and tricks you may use. Hopefully you can find something today to make your practice more fun!

General sedation

The “ket stun” works great for many procedures in small ruminants.

My preference for sedation is a “ket stun”

Recipe:

Butorphanol: 0.025 mg/kg

Xylazine: 0.05 mg/kg

Ketamine: 0.1 mg/kg

This may be administered SQ, IM, or IV. This dose will give a heavy sedation. For standing sedation a half dose is appropriate.

The butorphanol can be replaced with morphine if you can get it cheaper. Morphine (if replacing butorphanol) 0.025-0.05 mg/kg.

Often for quick procedures, I will choose just xylazine and butorphanol. Xylazine can be reversed easily. Do note that on rare occasions xylazine is known to cause death through pulmonary edema in sheep. I have personally only seen this once, of course in a valuable ram. We still use it commonly in sheep, and accept the risk. We recommend reversing xylazine with Tolazoline 1-2mg/kg IM (Label: 4mg/kg IV). You can get pseudo anaphylactic reactions with IV.

Also can consider:

Ketamine 1-2 mg/kg, Xylazine: 0.025-0.05 mg/kg IM/IV (Heavy sedation)

Butorphanol: 0.05 to 0.1 mg/kg +/- Xylazine: 0.05 mg/kg IM (Standing sedation)

Acepromazine: 0.05 to 0.1 mg/kg IM/IV

Local blocks with Lidocaine: remember the toxicity is 5 mg/kg and South American Camelids (SAC) 4mg/kg. I will take the 5 mg/kg dose dilute it to 0.6 to 1% with sterile water or saline and try to leave a quarter for reblocking if needed.

Llama (aka llama lullaby)

Butorphanol 0.0374 mg/kg

Xylazine 0.374 mg/kg

Ketamine 3.74 mg/kg

Alpaca

Butorphanol 0.0462 mg/kg

Xylazine 0.462 mg/kg

Ketamine 4.62 mg/kg

You may be wondering why the odd numbers. In the states we would use a 1, 10 ml bottle of 100mg/ml ketamine, add 1 ml (100 mg/ml) xylazine, and 1 ml (10 mg/ml)

Proceedings of AVA Annual Conference, Adelaide, 2016.

Fraser, B - Treating peri-urban small ruminants

butorphanol to the bottle. Then for llamas it was 1 ml/50 pounds (22.72 kg) and alpacas 1ml/40 pounds (18.18 kg). Though mixing these drugs is not an appropriate practice to my understanding in Australia. Also knowing the mg/kg is useful to do just one or two animals. This is a great heavy sedation for procedures such as teeth trimming or castrations. I prefer to give it IM and wait 10-15 minutes, while I leave them in a dark area.

Dystocia

Goat uteri tend to be the most friable. One must be the most gentle with goats. The pelvic inlet is much narrower. Assistance rate is around 5% varying by study of course.

As opposed to cattle abnormal posture is the most common reason for dystocia. You can have more luck manually dilating small ruminants than cattle.

Remember the 3 P's

Presentation: direction of the fetus in relation to the dam: (eg.) anterior, posterior, transverse)

Position: the relation of the fetus spine to the dams spine (eg.) dorso-sacral, dorso-pubis)

Posture: the relation of the fetus appendages to the body (head, thoracic and pelvic limbs)

Llamas and alpacas will have many more issues with abnormal posture. The pelvic inlet is narrow and long making manipulations similar to a mare. Sedation may be necessary and plenty of lubrication is essential.

These pseudo ruminants also have an increased incidence of uterine torsion. This most commonly occurs 2-6 weeks before parturition. The individual will present as a colic case. Though it is rarely at the time of parturition. I have only treated one at time of parturition in an alpaca. You can diagnose this by rectal palpation in all llamas and most multiparous alpacas. I prefer to place 10 ml of lignocaine in 300 ml of lubricant to help desensitize the rectal mucosa. A rectal ultrasound may also be used for determining the direction of rotation.

You will palpate the broad ligament transversing the abdomen from one far side of the abdomen and then diving abruptly on the other side of the uterus. These may be corrected surgically or with a rolling method similar to the cattle "plank in the flank." Though a SAC technically do not have a flank, so it has to be in the lower abdomen. A plank really does not secure well to the anatomy either, so no plank.

If it is a counter clock wise torsion place the individual in left lateral recumbency and roll. It turns into a two person job with one rolling the SAC and one person "kneading" the abdomen and foetus with their fists. The kneading person is attempting to stabilize the foetus as the dam rolls. Then the SAC is rechecked per rectum by palpation or ultrasound. This may be repeated 3-4 times before I will encourage a surgical correction.

Caesarean section

I will pursue a caesarean section when progress has not been made in 20 minutes or sooner if I have determined the foetus is alive and cannot be delivered vaginally. My preference for a caesarean section in a small ruminant is right lateral recumbency on a table so I can stand straight. I will secure the limbs, and head administer sedation and a local block.

Proceedings of AVA Annual Conference, Adelaide, 2016.
Fraser, B - Treating peri-urban small ruminants

My preference for sedation is a heavy sedation “ket stun”

This is administered half IV and half IM. I suggest having the animal clipped and a rough scrub before administering.

I typically get 45 min to an hour of sedation with this recipe.

In cattle acepromazine has less negative cardiopulmonary effect on the foetus than xylazine. Caesarean section can also be successful in SAC.¹

I will give a dose of pre sedation antibiotic and anti-inflammatory as well.

New born care

Place neonate in sternal recumbency and rub vigorously with a towel. GV 26 can be used to stimulate respiration.

Pharmaceuticals I use:

Dopram (doxapram hydrochloride)

2 mg: sublingual, IV

Oxygen!

Epinephrine (1:10000: 0.1 mg/ml)

0.1 ml: Sublingual, IV

Atropine (uncommonly) (15 mg/ml) LA

0.1 ml: IV or IM

Blood Transfusion

When: Clinical signs of anaemia Tachycardia, lethargy, hypoxia. We have all seen animals make recovery with real low PCV's without a transfusion. Though we seem to feel that about 8% PCV is the cut off point where a transfusion seems to save a lot of them that will not recover on their own. No published literature though. There is always the clinical decision as to if the stress will kill the animal though.

Transfusion is usually required due to Haemonchus, but not always. I treated a “mystery case” show lamb that did not have any Haemonchus on a fecal float. I blamed it on a chronic abomasal ulcer even though the fecal occult blood was negative. The sheep made a full recovery and did very well. It is important to remember it takes a great deal of blood to have a positive. If this test is positive I feel pretty good about it, though if it is negative, I cannot rule out a GI bleed in large animals.

How to do it?

Premade bags easiest for small ruminants

Or ACD solution

Citric acid anhydrous 4.8 g

Dextrose anhydrous 14.7 g

Sodium citrate 13.2 g

QS to 1000 ml with sterile H₂O

Dilute 1:5.4 to 1:9 with whole blood

Our pharmacy makes this for us, and I have never attempted to do it myself.

How much?

Usually my goal is not to make them normal, but to increase their PCV 5-8%. This will usually give them the jump start they need as long as the inciting problem is under control.

Formula

$80(\text{BW in kg}) * (\text{desired PCV} - \text{actual PCV} / \text{Donor PCV})$

Simple formula: 1 ml per pound of BW will increase PCV of recipient by 1% PCV

Proceedings of AVA Annual Conference, Adelaide, 2016.

Fraser, B - Treating peri-urban small ruminants

Thermos Fibrinogen²

Easy

Spin two hematocrit tubes

Record total solids on one

Heat second 56-58 C (132.8-136.4 F) for 3 minutes

Re-spin

Difference between two total solids in the fibrinogen concentration mg/dL

Field CSF Differential³

You should not be intimidated to do a CSF top on a production animal. With practice it becomes an easy procedure. If you get at least two millilitres of fluid, you can send one off for official analysis and evaluate one yourself for rapid information. This takes practice, so I would not use your only sample for this when you first start.

Apply slide to filter paper with hole

Apply upside down one millilitre syringe

Secure with clasps

Place CSF fluid into syringe

Allow to drain

Stain slide for differential

Gastro intestinal Parasite control: an integrated management approach

Management options: Control Programs

Parasitism is commonly thought of as an anthelmintic deficiency by many producers. We need to take an integrated management approach to this problem. In some places of the world, goats are maintained in dry lot scenarios to minimize parasites. Continual grazing of the same pasture by small ruminants can lead to serious buildup of resistant parasites. The prepatent period of *H. contortus* is actually shorter in the summer and is more heat tolerant than other parasites making this build up even more significant. A veterinarian can gain a lot of knowledge of a farms management by simply getting on the farm and observing. Simple mistakes can be corrected such as making sure the animal is receiving the dose of medication and half is not going to the ground.

Stocking rate

Greater than 2 sheep or goats per acre we risk increased pressure from stocking rate. I suggest 6-8 SAC/acre. It is also critical to monitor fecal management. Is the manure being removed and cared for properly? It is best to get some boots on the farm. You can evaluate congregation points to include feeding areas, watering areas, shade areas, and other points. Goats will commonly choose to utilize the same tree for shade each day.

Genetic management

It has been well accepted that a small percent of the animals shed a majority of the parasites. Commonly this is 30% shed 80% of the parasites. We do not fully understand the genetic components at play here. Though removing the high shedders can play a significant role. With consistent genetic selection for parasite resistance a producer can use significantly less medication. This can be a tough sell for genetically valuable groups.

Quarantine

Proceedings of AVA Annual Conference, Adelaide, 2016.

Fraser, B - Treating peri-urban small ruminants

It is far too common producers do not quarantine, especially “healthy appearing” individuals. People commonly pay a lot of money for parasites! I recommend 30 day quarantine. Ideally a fecal float should be performed at arrival to see what is being carried. At minimum treatment and a fecal float before moving into the remainder of the flock/herd should be performed.

Targeted Selective Treatment

By selecting only a proportion of animals to treat we are identifying the more at risk animals and leaving more refugia. Refugia is the population of parasites not exposed to anthelmintics. By leaving some parasites unchallenged a greater percent of parasites will remain susceptible to future treatments. Our goal should not be to “kill every parasite”. A particularly high risk time is parturition due to the concurrent rise in fecal egg counts. Treatment 2-3 weeks before the first parturition may help.

FAMACHA

Named after South African livestock parasitologist François "Fafa" Malan.

Pros

- Utilizes mm color (anemia) to detect animals in need of treatment
- Decrease AH usage
- Aids in genetic selection for resilience NOT resistance
- Easy to implement with proper training

Cons

- ONLY affective in diagnosing *Haemonchus*
- Breed differences in mucosa color
- Can be anemia associated with other issues
- CANNOT be used alone
- Implement with pasture management, dietary, etc.
- Requires frequent handling (q2-3wks)

More information

- Treat FAMACHA score of 3 if:
- >10% of animals are 4 or 5
- The animal is young and a 3
- Pregnant or lactating animals and a 3
- Poor BCS and a 3
- ALWAYS treat an animal with bottlejaw!
- Repeat in 2 wks during prime survival time
- Repeat every 4-6 weeks otherwise
- Sometimes a salvage option

QUANTITATIVE FECAL EXAMINATION

Any sick small ruminant can benefit from a fecal floatation. A single *eimeria macusaniensis* in an alpaca is significant. Quantitative procedures are used to determine the number of eggs or oocysts present in each gram of feces. These procedures give a rough indication of the number of parasites present within a host.

Proceedings of AVA Annual Conference, Adelaide, 2016.
Fraser, B - Treating peri-urban small ruminants

Even more important, quantitative exams indicate the extent of pasture contamination. Results of these tests must be interpreted with caution as several factors can influence the numbers of eggs or oocysts present. For example: (1) different parasite species produce eggs at different rates, (2) egg or oocyst production of some parasites can be sporadic and (3) diarrhea dilutes (reduces) the number of eggs or oocysts present in a certain quantity of feces.

MODIFIED WISCONSIN TECHNIQUE:

1. Weigh out 5 grams of feces.
2. Mix feces thoroughly with 45ml of water in a small cup.
3. Draw out 1 ml of suspended mixture and place into a 15ml tube.
4. Fill tube with sugar solution (sp. Gravity 1.27) and place a coverslip on the tube.
5. Centrifuge the tube at 1200 rpm for 5 minutes.
6. Remove coverslip and place on a microscope slide. Scan the slide counting all parasite eggs or oocysts seen.
7. Multiply the number of eggs or oocysts counted by 10 to determine the number of eggs per gram (EPG) of feces.

This protocol is sensitive to 10 EPG, therefore if no eggs are seen report as <10EPG not 0

Modified sheather's solution (SG 1.27)

454 g granulated sugar, 355 ml tap water, 6 ml formaldehyde

Dissolve sugar and water in the top of a double boiler OR with gentle heat. If solution is NOT clear, filter it through coarse filter paper.

Often just better to buy commercially available products

Fecal egg reduction test

- Labor intensive: many fecal floats
- 10-15 animals in a control, and same number in treated group. Fecal should have at least 150 EPG. 10-14 days after treatment perform fecal floats. % reduction = $100(1-(TM/CM))$ (TM=mean treatment count CM=Mean control count)
- Alternative: test 10-15 animals, treat, test same animals 14 days later.
- This is what I typically recommend

<80% reduction indicates some resistance. The lower the percent indicates a greater percentage of resistant worms.

Vaccines

Barbervax is now available and is labeled for both ewes and lambs. I feel this vaccine should not be used as a crutch or in place of your other management practices. This can be another tool that can be used in your integrated management approach. Two drawbacks are that it only comes in 250 dose vials, and is labeled for a minimal 3 injection scheme.

Copper Oxide Wire Particles

Proceedings of AVA Annual Conference, Adelaide, 2016.
Fraser, B - Treating peri-urban small ruminants

Doses range from 0.5 to 6 g per head. Up to 10 g per head has been reportedly administered without toxicity. This may not be an appropriate treatment for sheep due to their sensitive nature to copper. Areas that have higher copper levels in the plants and soil may not be an appropriate place to implement this treatment. Texel and dairy breeds are especially sensitive to copper toxicity.

Do not use copper sulfate, as this is absorbed faster and is more likely to cause toxicity. The exact mechanism of action is not understood. They create an environment that is unfavorable for adult *H. contortus* worms to live. This is only significantly efficacious against *H. contortus*. Reported reductions have been up to 96% while only a 56% reduction in *Teladorsagia circumcincta*.

Nematode Trapping fungi

Perhaps in the future this will become commercially available and provide another tool in the fight against gastrointestinal nematodes. Possibly effective against all major parasites of small ruminants. These products are fed to small ruminants, and have to be fed daily. The spores pass through the gastrointestinal tract and reside in the feces. The fungi kills the larvae hatching in the feces. *Duddingtonia flagrans* is the most studied fungi, and showing promise.⁴

Rotation/Pasture Management

Rotating with other species to include cattle and horses is an excellent method to minimize pathologic species of internal parasites of small ruminants. These species usually do not become infected with most of the parasite species.

Haemonchus contortus of small ruminants

- Can affect calves

- Don't place calves on heavily affected pastures

- Can affect camelids!!!

Haemonchus placei (cattle)

- Can affect sheep: not a major pathogen

Trichostrongylus axei

- Can affect cattle and horses

- Not recognized as a significant pathogen in mixed grazing

Haying a pasture can help with egg reduction. Nematodes will only survive the process for about one month in hay. This also allows for greater sunlight to the remainder of the pasture to help kill the eggs still left.

Resting the pasture can also significantly reduce the parasite load on the pasture. Sometimes with rotational management congregation sites are not changed and should be monitored as a source of infection. These may include shelter or water sources. Over grazing is a common source of infection. 80% of the larvae reside at under 4 inches of grass.

- Pasture rest to lower worm burden
 - Hot weather: 3 months
 - In the 90's+: 6 weeks
 - Cool weather: 6 months

Protein supplementation

Providing protein supplementation can help to aid in parasite control. A crude protein of approximately 19% increases IgA.⁵ This can affect adult worm burden and eggs per gram. Superior nutrition can also aid in the animals resilience to parasites.

Proceedings of AVA Annual Conference, Adelaide, 2016.
Fraser, B - Treating peri-urban small ruminants

High Tannin containing plants

Sericea lespedeza has been one of the more studied plants. There has been several studies showing a reduction fecal egg counts when goats are fed this plant in high quantities. Other benefits of high Tannin plants in ruminants include reducing bloat, green house gas emissions and increases the amount of protein to by-pass the rumen. Reduction in intake or refusal to eat these forages may be present.⁴ High tannin containing plants may be an effective method of controlling gastrointestinal parasites in small ruminants.⁶

Anthelmintics

I commonly get the question “what is the best anthelmintic (dewormer)”. It’s a difficult question to answer. There are a few guidelines that can help to guide us. Wormboss.com is an excellent resource and is commonly used. It has been suggested to minimize the amount of long acting anthelmintics.⁷ Though they have a place in my opinion at high risk times and to break the buildup of parasites. Primer and exit drenches may be useful for the high risk season. They should be short acting and be a different active ingredient than the long acting. Rotating anthelmintics is controversial at best. I do not like aggressive rotation. It has been suggested to utilize a new class of anthelmintic in the late summer to fall to remove resistant genotype worms which have accumulated over previous treatments.⁸

Urolithiasis

Diet

“An ounce of prevention....” Holds ever so true with this disease and nutrition is key. Be aware you will see clinical disease commonly during weather change resulting in decreased water consumption.

Phosphorus <0.6%

Magnesium <0.2%

Ca:P= 2:1 to 2.5:1

NaCl: 1-4% of diet

Ammonium Chloride

1-2% of diet

Long term use of ammonium chloride may predispose to osteoporosis.

NaCl:

3-5% of DMI

Formula examples:

DMI ~2% of BW

25 kg goat x 2%=0.5 kg

0.5kg x 4%=20grams = ~1 tbs (3 tsp)

Ammonium chloride:= ~1 tsp

We suggest a strict grass hay diet! Owners of pets commonly want to give snacks. Chose snacks low in calcium and phosphorus and still in moderation. Ex) carrots, green bean, cabbage, cucumber. Feed high in phosphorus including grains and feeds high in calcium such as lucerne should be avoided!

How to diagnosis it?

Proceedings of AVA Annual Conference, Adelaide, 2016.

Fraser, B - Treating peri-urban small ruminants

If you have a male small ruminant present to you, have urolithiasis on your differential list. In my book they have urolithiasis until I witness a solid urine stream! The animal may vocalize strain, “appear constipated”, lethargic, really highly variable. Place a hand ventral to the anus to identify pulsing. Identify any crystals near the sheath. Prevention is much better than treating these cases. An integrated approach may be taken for prevention.

Anatomy

The two most common sites for obstruction include the distal sigmoid flexure (Insertion of retractor penile muscle) and the vermiform appendage. It is important why catheterizing the bladder is difficult. They have a urethral recess in the proximal portion of the penis. The catheter tends to go into this recess. A catheter will rupture this portion of the urethra if forced. The debate about urethra diameter is significant, though is more significant in lambs. Lambs castrated at 5 months vs. 2 weeks have a urethra diameter 3.5x wider, and when castrated at 3 months vs. 2 weeks the diameter was 2.5 x wider. In kids it has been wider but not significantly. We suggest trying to wait until 3 months of age to castrate a pet.

Diagnostic tests?

Will depend on the animals value and degree of illness. My physical exam may be my only diagnostic test. For the pet goat with a financially committed owner I will perform blood work and ultrasound. An ultrasound can always be useful. The blood work helps you to identify any additional infectious process and what fluids and additional therapies may be indicated. The ultrasound can help determine injury to the kidneys, the size of the bladder and if there has been any leaking of the urine into the abdomen. We rarely perform radiographs, though they can help determine the severity of disease if there is a whole string of uroliths in the urethra, or if the urethra as ruptured. I have also performed contrast studies on rare occasions with select cases.

Sedation options?

Yes xylazine causes increased urine concentration. It is ideal to avoid this pharmaceutical.

Consider: Butorphanol: 0.05-0.1 mg/kg and/or Acepromazine: 0.05-0.01 mg/kg

Treatment options

There are certainly a range of treatments all with their limitations, and no ideal treatment.

The first step is to extend the penis and amputate the vermiform appendage AKA urethral process. This needs to be done flush with the penis. Leaving any remnant may defeat the purpose. This is often a long term solution. It may buy you 24-36 yours to acidify the urine and negate further surgical intervention. To accomplish amputation, place the animal on his rump, and manually extend the penis. This is not possible on all animals. For example the frenulum may have never broken down. Acepromazine at a 0.05 mg/kg dose or diazepam 0.1 mg/kg dose may facilitate you.

Cystocentesis

Proceedings of AVA Annual Conference, Adelaide, 2016.
Fraser, B - Treating peri-urban small ruminants

It is preferable to perform this under ultrasound guidance and necessary if you will be injecting an acidifying substance directly into the bladder. Utilizing Walpoles solution one study had an 80% success in treating urolithiasis in goats.⁹ To accomplish this urine is aspirated out and with the needle left in place Walpoles is injected back into the bladder, and repeated until a pH of 4-5 is obtained. This will take between 50-250 mls of solution.

Perineal Urethrostomy (PU)

Most commonly a penile amputation is also performed. If possible preserve the dorsal penile vein. This procedure eliminated future potential breeding. There are high and low versions of this procedure. I will perform a low on a first time offender to allow a repeat high PU. The low PU is performed near the scrotum. I prefer to make it at the point where the rump starts to curve cranially. The high Pu is performed a couple centimeters below the anus. Be careful not to amputate too short. I will say this procedure is a salvage procedure and they will restricture at 8 months. Some may go on for years and be fine, but I prefer the owner to be prepared. A recent study on repeat offenders has had 11 of 12 animals be discharged with 9 having not restructured after 12 months.¹⁰ The unique characteristics of this procedure involve cutting the attachments of the penis to the pubis. This is difficult, as they are closely adhered in a narrow space. Also careful muco-cutaneous suturing of the urethra to the skin is critical.

Tube cystotomy

This is considered the most successful procedure for long term success. (Ewdolt et al 2008) It has been up to 86% successful. This is also the most costly and requires the most time commitment. Average time to urination has been reported at 11 days.¹¹ This procedure is most often priced out similar to a small animal surgery under general anesthesia. I did have a goat that ruptured his urethra with an unclamped tube in place. Most good large animal surgery texts have descriptions of this procedure.

In vague terms the animal in under general anesthesia and a Foley catheter is placed into the bladder and directed just off ventral midline. This allows redirection of the urine until acidification can establish normal flow of the urine. The advantage of this procedure is breeding soundness is maintained and the PU was not performed leading to a stricture. The owner must realize this is not a permanent cure and the goat may restructure particularly without lifestyle changes of the goat with proper total mineral intake.

Bladder marsupialization

This procedure involves suturing the bladder to the ventral abdomen. The animal loses urinary continence and may not be a viable option for pets. Success rates have been reported to be between 66% and 84%.¹¹ This is actually similar success rates to tube cystotomies. Some surgeons prefer this method and find higher success rates than the tube cystotomy.

Medical management

Proceedings of AVA Annual Conference, Adelaide, 2016.
Fraser, B - Treating peri-urban small ruminants

Urine acidification

The goal is to achieve a urine pH of 6-7 to help dissolve struvite and apatite stones. Other stones do not respond to acidification. To accomplish this, use 100mg/kg ammonium chloride PO Q12. This will usually take 1-2 days to observe changes. If after two days the urine pH has changed increase the dose by 10% at a time to effect. If the urine pH falls below 5.5, the animal may be going into an uncompensated metabolic acidosis. You must stop the ammonium chloride or decrease by 10%. Monitoring pH is important twice a day for the potential of metabolic acidosis. Please note this is poorly palatable and interferes with compliance.

Fluid therapy

Once the obstruction is resolved diuresis can be of a great benefit. If the animal is not stable for surgery, cystocentesis may be performed and fluid therapy instituted. A cystocentesis is not without complications, as you may cause excess urine leakage into the abdomen. Without blood work 0.9% NaCl is my fluid of choice. It is mildly acidifying, but more importantly is free of potassium.

Antibiotics

An antibiotic that is concentrated in the urine is desirable if you suspect injury to the urinary system or perform surgery. Beta lactam and cephalosporins are great choices. Our go to drug of choice is ceftiofur.

Anti-inflammatories

We will place the patient on flunixin or meloxicam.

Common uroliths in small ruminants

Magnesium ammonium phosphate (struvite): Occur at pH 7.2-8.4

Calcium phosphate (apatite): Occur at pH 6.5-7.5

These are similar in appearance and are sharp, gritty and white. They do respond to urine acidification. Reduce cereal grains high in Phosphorus. Maintain a Ca:P ration ~2:1 and Mg <0.3% DMI.

Calcium carbonate form in alkaline environments, though are not responsive to urine acidification.

They look like Copper BB's. The animal should avoid lucerne and other high calcium feeds. Also maintaining a proper Ca:P ratio is important.

Silica: Formed in animals on sandy soils and consuming plants high in silica. These are found more commonly in the western states. Acidic urine predisposes to this stone.

Oxalate: Animals are predisposed if consuming oxalate-containing plants.

1. Miller BA, Brounts SH, Anderson DE, et al. Cesarean section in alpacas and llamas: 34 cases (1997-2010). *J Am Vet Med Assoc* 2013;242:670-674.
2. Jones ML, Allison RW. Evaluation of the ruminant complete blood cell count. *Vet Clin North Am Food Anim Pract* 2007;23:377-402, v.
3. Bohn AA, Callan RJ. Cytology in food animal practice. *Vet Clin North Am Food Anim Pract* 2007;23:443-479, vi.

Proceedings of AVA Annual Conference, Adelaide, 2016.
Fraser, B - Treating peri-urban small ruminants

4. Terrill TH, Miller JE, Burke JM, et al. Experiences with integrated concepts for the control of *Haemonchus contortus* in sheep and goats in the United States. *Vet Parasitol* 2012;186:28-37.
5. Holmes PH. Interactions between parasites and animal nutrition: the veterinary consequences. *Proc Nutr Soc* 1993;52:113-120.
6. Min BR, Hart SP. Tannins for suppression of internal parasites. *Journal of Animal Science* 2003;81.
7. Leathwick DM, Besier RB. The management of anthelmintic resistance in grazing ruminants in Australasia--strategies and experiences. *Vet Parasitol* 2014;204:44-54.
8. Leathwick DM, Hosking BC. Managing anthelmintic resistance: modelling strategic use of a new anthelmintic class to slow the development of resistance to existing classes. *N Z Vet J* 2009;57:203-207.
9. Janke JJ, Osterstock JB, Washburn KE, et al. Use of Walpole's solution for treatment of goats with urolithiasis: 25 cases (2001-2006). *J Am Vet Med Assoc* 2009;234:249-252.
10. Tobias KM, van Amstel SR. Modified proximal perineal urethrostomy technique for treatment of urethral stricture in goats. *Vet Surg* 2013;42:455-462.
11. Ewoldt JM, Jones ML, Miesner MD. Surgery of obstructive urolithiasis in ruminants. *Vet Clin North Am Food Anim Pract* 2008;24:455-465, v.