Management strategies for infectious disease control in a variety of production systems

Joan Dean Rowe, DVM, MPVM, PhD, DACVPM
Department of Population Health and Reproduction, School of Veterinary Medicine, University of California, Davis, CA 95616, jdrowe@ucdavis.edu

Abstract

Strategies for disease control in goat herds should be individualized to account for the diversity in management type, risk levels, and owner factors. Goat herd type, for example dairy, meat, fiber, companion or other; intensive or extensive management; confinement, grazing or browse; as well as owner's experience level, beliefs and budget all must be considered in planning prevention and control programs for contagious disease in goat herds. Caseous lymphadenitis, caprine arthritis-encephalitis virus, Johne's disease, *Mycoplasma* spp infections, contagious abortion agents, and scrapie all should be considered in planning an integrated pathogen control program to address as many diseases as possible using the same critical control steps in disease management. Pasteurized kid-rearing programs, disease-specific testing and segregation, testing and removal or culling are strategies commonly employed for important infectious diseases. Optimizing and economizing herd diagnostic surveillance through routine necropsies and selective herd testing provide the basis on which sound, informed decisions can be made. Conscious decisions should be made whether to tolerate, control or eradicate each important infectious disease in the herd or, if not in herd, what resources should be committed to preventing the introduction of agents causing lifelong infection in the adult herd.

Key words: goats, herd health, diagnostics

Résumé

Les stratégies de lutte contre la maladie dans les troupeaux de chèvres doit être adaptée pour tenir compte de la diversité de type de gestion, les niveaux de risque et les facteurs de propriétaire. Troupeau de chèvres type, par exemple les produits laitiers, la viande, les fibres, compagnon ou autres ; intensif ou extensif ; gestion de l'accouchement, le pâturage ou parcourir ; ainsi que le niveau d'expérience du propriétaire, de croyances et de budget doivent tous être pris en compte dans la planification de programmes de prévention et de contrôle des maladies contagieuses dans les troupeaux de chèvres. Lymphadénite caséeuse, l'arthrite-encéphalite caprine virus, la maladie de Johne, Mycoplasma spp infections, avortement épizootique, et tous les agents de la tremblante devraient être considérés dans la planification d'un programme intégré de contrôle des agents pathogènes d'adresse que de nombreuses maladies que possible en utilisant les mêmes mesures de contrôle critique dans la gestion des maladies. Kid-pasteurisé, programmes d'essais spécifiques à la maladie et la ségrégation, les essais et l'élimination ou l'abattage sont des stratégies couramment pour maladies infectieuses importantes. Optimiser et économiser de diagnostic de routine grâce à la surveillance du troupeau et les autopsies troupeau sélective offrent la base sur laquelle des décisions peuvent être prises. Conscients que les décisions devraient être prises à tolérer, contrôler ou éradiquer les maladies infectieuses importantes dans le troupeau ou, si ce n'est pas en troupeau, de quelles ressources devraient être déterminés à empêcher l'introduction d'agents causant l'infection dans le troupeau adultes.

Introduction

Many of the chronic infectious disease problems in the goat herd are lifelong infections from exposure of kids near the time of birth. Infectious disease control programs start with planning kid-rearing strategies to minimize infection of the neonate. Pasteurized rearing strategies are commonly used to prevent mycoplasmosis and caprine arthritis-encephalitis virus (CAEV); however, pasteurized rearing (with age segregation) also reduces the risk of Johne's disease (*Mycobacterium paratuberculosis*) and caseous lymphadenitis (CL, *Corynebacterium pseudotuberculosis*). Removing kids from the kidding/maternity pen environment would reduce potential exposure to the scrapie agent in infective placental tissues. Pasteurized rearing alone will reduce the overall prevalence of these diseases, but serologic testing and segregation or culling is needed to fully control CAEV. Similarly, pasteurized rearing must be combined with milking hygiene measures, routine milk cultures and segregation for mycoplasma control. Serologic testing and segregation or culling may be used in herds with low incidence of CL, while premises hygiene, vaccination, and isolation of affected animals will be main strategies used to control CL in heavily infected herds. Integrated approaches to control the chronic infectious diseases acquired early in life can greatly enhance longevity of goats in the herd.

Strategies for Approaching Infectious Disease Control

What is the current herd status with respect to each disease of interest? A herd with 70% mycoplasma prevalence will

likely adopt a control strategy first, followed by an eradication strategy after prevalence is reduced to a level that would economically allow complete removal of infected goats.

What is the current herd status with respect to other infectious and metabolic diseases? Concurrent infections and nutritional deficiencies may result in more severe clinical expression of a disease of interest. Co-infection with agents with common tissue trophism (e.g. CAEV and mycoplasma) may modify resistance to and clinical outcome of disease.

Does a records infrastructure exist to allow prevention and management of infectious disease? Most chronic infections are lifelong, and ability to categorize goats by disease status and trace risk to the postnatal environment are key to success in infectious disease control.

Are the goats commingled or share risk of exposure with other species? Scrapie and CL are shared between sheep and goats. Johne's risk assessment should include all animals on the farm as well as off-farm sources of milk and colostrums. Caprine and ovine lentivirus control programs should be considered together as part of a herd approach to CAEV control.

Is the herd closed (raises all their own replacements) or open (and to what degree), and what are the owner's long-term goals with respect to herd replacements? In some cases, raising replacements may be the only way to maintain high standards of herd health. In other cases, susceptible replacements coming into a herd may be at high risk of massive exposure and high likelihood of clinical expression of disease.

What are the owner's goals for the herd, and what will the budget allow? Costs of pasteurized rearing programs and serologic/necropsy surveillance for disease will need to be assessed in prioritizing disease control strategies. The veterinarian and the producer may have different views of a tolerable level of endemic disease.

Caprine Arthritis-Encephalitis Virus (CAEV) Infection

Caprine arthritis-encephalitis virus infection is a lifelong lentivirus infection affecting monocytes and macrophages. The major route of transmission is via colostrum and milk. Postweaning transmission of CAEV occurs following prolonged contact between susceptible and infected goats. Long-term, high-density commingling of infected and susceptible goats would favor the likelihood of effective contact. Clinical signs associated with CAEV infection include adult-onset polyarthrtitis and polysynovitis, leukoencephalomalacia of kids 2 to 6 months of age (rare), and histologic mononuclear infiltrative changes in lung, CNS, and mammary gland. Approximately 35% of infected goats will develop the most frequent clinical sign, polyarthritis, during their productive lifetime. Diagnosis is based on clinical signs, serologic testing, testing for virus-infected cells by PCR or by necropsy. This lifelong infection has no effective treatment; infected goats shed the virus in their milk.

Pasteurized kid-rearing methods are the cornerstone of prevention of milk and colostrum as a route of CAEV infection. Additionally, the long-range success of a CAEV prevention program lies in identification and segregation or removal of infected goats. Serologic testing is the most practical means of herd surveillance for CAEV infection. Since CAEV infection is lifelong, the presence of antibody is presumptive evidence of CAEV infection.

Heat-treatment of Colostrum and Pasteurization of Milk

Heat-treating colostrum for 60 minutes at 134 °F (56 °C) has been shown to prevent transmission of CAEV or *Mycoplasma* spp to kids. Colostrum can be heated in a double boiler, pasteurizer or water bath to 135 °F (57 °C) and held in a preheated thermos bottle or stable water bath for 60 minutes, with exit temperatures carefully monitored. Care must also be taken to assure even heating of colostrum to prevent failure of the method. Heat-treated colostrum can then be frozen for later use. Colostrum that exceeds 138 °F (59 °C) tends to denature immunoglobulins and develop clumps. Overheated colostrum should be discarded, as feeding it usually results in osmotic diarrhea.

Standard pasteurization has been recommended for milk to be fed to kids. Minimum pasteurization temperature of 165 °F (74 °C) for 15 seconds is recommended for control of other pathogens such as *Coxiella burnetti*. Pasteurization can be done on a stove or in small commercial pasteurizers, but routine monitoring of exit temperatures and times are necessary to prevent failures in pasteurization due to inadequate temperature or duration of treatment.

Raw cow colostrum and milk have been used for CAEV and caprine *Mycoplasma* spp prevention. Although successful in preventing transmission of these caprine pathogens, herd biosecurity may be compromised by the potential for introduction of *Mycobacterium paratuberculosis*, *Salmonella* spp, or other pathogens with less species specificity. Quality of cow colostrum and milk are still essential in assuring successful passive transfer and preventing colibacillosis and other opportunistic infections. Artificial colostrum replacers have been used successfully in some herds.

Control of CAEV in Goat Herds

Recommendations to prevent CAEV transmission should be considered a permanent part of herd health management programs. Many producers have been disappointed at the reemergence of CAEV infection or the appearance of *Mycoplasma* spp infection after discontinuing pasteurization and segregation procedures. A negative herd serologic status is not a guarantee of a negative herd infection status.

Many factors including delayed seroconversion, viral latency, restricted viral replication, herd management, and limitations of available tests for detecting infected animals make the goal of eradication of CAEV difficult to achieve. Although eradication may be difficult to achieve, the economic impact of CAEV infection is markedly decreased when herd prevalence is low. Even on premises where testing and segregation cannot be implemented, pasteurized rearing alone (removal at birth and feeding of heat-treated colostrum/pasteurized milk) significantly reduces the economic impact of disease by delaying the time of infection.

In meat goat herds or other herds where kids are raised on their dam, prevention of infection of herd replacements is accomplished by testing and segregating doe/kid pairs based on CAEV status. Prevention of introduction of CAEV into an uninfected group or herd would require repeated testing strategies.

Recommendations to control CAEV infection are:

1. Prevent perinatal transmission by removing kids at birth without allowing contact (sniffing, licking) with the doe. Kids may be rinsed in warm water to remove cellular debris of maternal origin, as long as kids are thoroughly dried. Cardboard boxes can be used to house separate litters of kids for the first few weeks of life; disposable boxes aid in preventing transmission of neonatal pathogens.
2. Prevent milk-borne transmission. Although heat-treated colostrum and pasteurized goat milk are recommended, there may be some risk associated with feeding heat-treated colostrum from infected does to kids. Diligent monitoring of treatment times and exit temperatures is critical to the success of pasteurization programs. Additionally, pasteurized milk should be marked with food coloring to minimize the risk of accidentally feeding unpasteurized milk to kids, particularly if several people are involved in the care of kids. Heat-treatment of cow colostrum and pasteurization of cow milk, if possible, is desirable to assure its microbial quality and prevent colibacillosis and other neonatal infections in kids. Cow colostrum, cow milk, and high-quality milk replacer are alternatives to feeding goat colostrum and milk. Processed commercial colostrum products and hyperimmune serum give variable results. Feeding cow colostrum or heat-treated colostrum from seronegative does allows the opportunity to confirm suspected accidental nursing of seropositive does via detection of colostral titer in kids.
3. Maintain a serologic surveillance program at intervals determined by existing herd prevalence and herd goals. PCR testing may be used to clarify an animal's serologic status or as an additional means of screening herd introductions for potential infection.
4. Segregate or cull seropositive animals. Segregation must be complete with either solid barriers or a 2 to 3 m alley between seropositive and seronegative goats. If possible, pen grouping of goats by age and restricting group size will limit exposures to smaller groups of goats. Ideally kids born to seropositive does should be housed separately until serologic status can be determined and monitored. Feeders and waterers should not be shared, and commingling of seropositive and seronegative goats should not be allowed (for example, during transportation or housing at shows).
5. Milk seronegative does before milking seropositive does, and milk younger does before older does.
6. Potential for venereal transmission of CAEV exists. When possible, breed seronegative does with seronegative bucks. If seronegative and seropositive animals are mated, single hand-mating allowing minimal oral or oral-genital contact is advised.
7. Avoid potential risk of iatrogenic transmission. Do not share needles, tattooing equipment, or dehorning instruments without taking measures to eliminate virus and virus-infected cellular debris.

In herds which commingle with sheep, control programs should also include control of ovine progressive pneumonia virus (OPPV). The major route of OPPV infection in sheep is by close contact and transmission of virus by respiratory secretions over long periods of commingling of infected and susceptible sheep. As suggested by the name, chronic respiratory signs, dyspnea, exercise intolerance, and weight loss are common signs. Hard udder/agalactia may result in hungry, low-growing lambs from affected ewes. Principles of testing are the same as for CAEV, and these antigens cross-react. Testing and segregation or testing and removal are the cornerstones of OPPV control.

Mycoplasma Infections in Goats

Mycoplasma mycoides spp *capri* (formerly *M. m.* spp *mycoides* (large colony type) is a highly pathogenic mycoplasma that may cause mastitis, polyarthritis, pneumonia, meningitis, abortion, and occasionally sudden death. Most commonly, outbreaks present as polyarthritis in goat kids being fed raw goat's milk occurring concurrently with mastitis in adult milking does. Joint fluid from affected kids and/or milk from affected does can be cultured to confirm the diagnosis. Mortality in kids and does, as well as abortions, may also be reported by the owner. In herds with endemic infection, kid morbidity (polyarthritis/pneumonia) may be the predominant complaint while milking herd exposure through the purchase of an infected doe(s) will present most commonly as mastitis and abortions, followed by polyarthritis in kids. Asymptomatic clinically infected does will often shed the organism after a stress such as movement to a new herd, or even to a new pen on the dairy. Herd outbreaks may have a prolonged history with infection of the milking does occurring in one lactation and infection of kids occurring during the

subsequent lactation. Antibiotic treatment of goats infected with mycoplasmosis is unrewarding, as recovered animals are usually intermittent shedders throughout their life.

Mycoplasma putrefaciens - This mycoplasma is generally implicated in outbreaks of a highly contagious mastitis characterized by a fibrino-purulent odorous exudate and sudden agalactia. Does may shed the organism for 3 to 10 days prior to the onset of clinical signs. Increased California Mastitis Test (CMT) scores or somatic cell counts (SCC) without clinical mastitis may be the first sign of infection. Clinical illness (fever and anorexia) associated with *M. putrefaciens* is highly variable. In a few outbreaks does with polyarthritis and kids with polyarthritis and pneumonia have been reported. In these instances the goats had concurrent nutritional deficiencies, disease or other management problems. Control of *M. putrefaciens* is based on identification of the organism and instituting strict milking sanitation procedures as described below for *M. mycoides* spp *capri*. Isolation of infected does is ideal, but practically speaking the outbreak is often well advanced and exposure rate high by the time the diagnosis is confirmed. At the least, young fresh does should be milked first and not mixed with older milkers. Kids on the dairy should not be fed raw goat colostrum or milk. Complete cleaning and sanitation of the milking system is essential or there will be viable organisms present at the next milking. Routine culturing of bulk-tank milk will help to prevent explosive uncontrollable outbreaks of mastitis.

Recommendations for Mycoplasma Control in Goat Herds

Pasteurized kid-rearing programs used as the basis for CAEV control programs are the cornerstone of Mycoplasma prevention programs. Several management practices should be considered for preventing mycoplasma transmission. In dairy herds, control of *Mycoplasma* spp in the adult goat requires repeated culture of milking does to detect infected does, which are then culled to slaughter. Less desirable, but necessary in high-prevalence herds, is the formation of an infected milking string(s) which is (are) housed separately and milked last. Extreme attention to milking sanitation is required to prevent doe-to-doe transmission. Does should be spray pre-washed or pre-dipped and individual paper towels used to dry the udder. Post-milking teat dipping (and assuring thorough application of teat dip) is essential and milkers must wear gloves and disinfect them between does. Teat cups should be back flushed or dipped in disinfectant between does and proper clean-up of the pipeline and milking equipment must be done after every milking. Does with elevated CMT, elevated SCC or clinical mastitis should be removed at once from the milking string and a milk sample frozen for culture. Initially for 2 to 6 weeks, bimonthly milk cultures are taken until new cases are not detected for 2 culture periods, then monthly samples for 2 to 3 months followed by string pooled samples for 6 months. Dairies should have weekly samples frozen from the tank for routine monitoring, and increases in SCC or CMT on the dairy should be aggressively pursued. Infected groups of kids should be culled to slaughter and only kids fed heat-treated colostrum, cow colostrum (note Johne's disease risk) and pasteurized goat, cow milk or milk replacer should be retained for replacement.

In meat goat herds, or other herds where kids are raised on their dams, the cornerstone of mycoplasma control is to 1) prevent the introduction of mycoplasma-infected animals into the herd by culture of milk and potentially ear swabs; 2) segregate breeding does by level of risk; and 3) adopt an artificial kid-rearing program to generate an uninfected pool of replacement females. These kids should be maintained segregated from "exposed" herd through a period of total herd replacement.

Control of mycoplasma in a herd requires a long-term commitment by the producer, as there may be undetected animals in the herd for months, if not years, after the adoption of a control program. Accidental nursing of kids may result in undetected milk-borne mycoplasma transmission. Milking practices may facilitate efficient intramammary transmission among lactating does. Biosecretions from aborted does and does with pneumonia should be considered potentially high risk. Because special media are required to culture mycoplasma organisms, infections may go undetected until a clinical crisis occurs. Practitioners should be sure to request mycoplasma cultures on all suspected necropsies and milk samples. Recovery from clinical disease is often followed by conversion to an asymptomatic carrier status with intermittent milk shedding of mycoplasma most often when animals are stressed. Long-term surveillance by milk culturing is necessary to detect infected does. The ear mites *Psoroptes cuniculi* and *Raillietia capri* may carry multiple species of mycoplasma and may represent a natural reservoir for pathogenic *Mycoplasma* spp. Ear cultures and control of ear mites may be warranted as an added control point in some eradication and prevention programs.

Caseous Lymphadenitis (Contagious Abscesses, CL)

Abscesses caused by *Corynebacterium pseudotuberculosis* result from lifelong infection with recurring abscesses of the regional lymph nodes. Draining of external abscesses results in transmission to other sheep and goats by direct contact, and indirectly by contamination of feeders, equipment and the environment. The organism remains viable for months in the environment and remains a source of long-term transmission by ingestion or inoculation to susceptible goats. Abscessation of internal lymph nodes may result in chronic weight loss and premature culling. Definitive diagnosis is by culture of pus from an abscess, necropsy. Serologic testing with the synergistic hemolysin inhibition (SHI) test will detect exposure to the organism and can be used to exclude exposed and potentially infected animals from herd introduction and as an aid to segregate or remove goats as part of a

herd cleanup program. Serologic testing and segregation or culling may be used in herds with low incidence of CL, while premises hygiene, vaccination, and isolation of affected animals will be main strategies used to control CL in heavily infected herds.

Intensive management of clinical abscesses with early detection of ripening abscesses, isolation of the goat until the abscess is healed, lancing abscesses in an isolated environment, and preventing cross-contamination of premises and potential fomites are keys to successful management. Fly control will reduce dissemination of the bacterium among goats. Premises disinfection and herd segregation on the basis of infection status will reduce the incidence of new infections in the herd. Vaccination with commercially available sheep CL vaccine, conditional-license goat vaccines or with autogenous bacterins can be used to reduce the number of goats with abscesses and the number of abscesses per animal, thereby reducing the overall herd exposure in endemic herds.

Johne's Disease Management

Johne's disease risk management plans similar to those for cattle are appropriate for goat herds. Pasteurized kid-rearing programs designed for CAEV and mycoplasma control reduce exposure to *Mycobacterium avium* sub spp *paratuberculosis* (MAP) in the maternity-pen environment. Segregation of preweaning and juvenile goats in the commercial herd help to prevent exposure to MAP until kids enter the adult herd. In utero transmission and identification of "safe" colostrum sources should be considered, even where heat treatment of colostrum is used. If outside sources of milk and colostrum are used for kid rearing, including cow milk/colostrum, potential risk of infection should be considered. In dairy herds adopting pasteurized rearing programs alone, a reduction in clinical Johne's cases is often observed. Johne's risk assessment in the herd should include cattle, sheep, and other Johne's-susceptible species as part of an overall farm plan. Availability of affordable testing by serology and/or fecal culture for MAP infection varies from state-to-state. Specific testing strategies are less well defined for goats than for cattle. Similarly, vaccination strategies may be possible in infected herds under the cooperation of regulatory veterinarians.

Scrapie

Although scrapie is assumed to be less prevalent in goats than in sheep herds in the US, surveillance for and prevention of introduction of scrapie into goat herds is critical. Herd replacement sources should provide official identification and traceback information, and buyers should research for potential risk associated with commingling of does with lambing ewes. Veterinarians should consider scrapie as a differential diagnosis for any progressive weight loss or neurologic disease, and the herd health plan should include necropsy of all animals with chronic wasting and/or progressive neurologic signs. All sheep and goats, including companion or backyard animals, must comply with mandatory National Scrapie Eradication Program identification and records requirements.

Ongoing Disease Surveillance

Successful control for chronic diseases relies on continued disease surveillance. Management decisions regarding disease control grouping, treatment, production, and culling should be based on accurate lifelong records on each animal. Unique individual animal identification (tattoos, ear tags, neck tags, etc.) is needed to before permanent accurate records can be maintained to monitor infectious disease status. Dam disease status and colostrum source are needed as part of the permanent doe record.

Planned routine necropsy of selective herd culls as well as deaths will allow monitoring for all major contributors of disease in the herd, not just primary cause of death. Additional testing for tissue copper and selenium, parasites, and other items of interest can help identify concurrent disease problems which may confound the efforts of a specific disease control program. Johne's, scrapie, CL, CAEV, and mycoplasma can all be monitored by necropsy even though the cause of death may be unrelated to these diseases.

Serologic testing for CL or CAEV may be part of an ongoing control program for the herd or used to screen new herd introductions. Ongoing serologic surveillance for CAEV will allow effective segregation of infected animals to reduce adult transmission of disease. Milk cultures for mycoplasma and other contagious pathogens allow for ongoing reduction or elimination strategies.

Culling

Planning for removal of sheep or goats from herds of all sizes and uses is critical to monitoring for disease, reducing disease risk, and maintaining optimal use of resources. Small or "backyard" herds often develop issues with overcrowding or conversely lose the opportunity to make desired matings because of excessive animals (and overcrowding) in the herd that are unmarketable, of advancing age or otherwise beyond serving their initial purpose. In herds where normal culling channels are not appropriate, the veterinarian can assist owners by planning castration and adoption (healthy animals) or, if indicated, euthanasia of animals (diseased) to maintain a herd of sound, healthy animals that will allow the owner to meet the goals of their breeding program. Euthanized animals submitted for necropsy can play a vital role in mineral nutrition and infectious disease surveillance in the herd.

Conclusion

Goat herds are highly diverse, and individualized approaches are needed to design herd health programs that

meet the needs of the herd owners–taking advantages of their strengths and interests while taking their constraints into consideration. Thoughtful consideration of which health issues are limiting herd productivity and helping the owner prioritize disease management strategies will help to build a sustainable approach to health management which will afford the producer continued long-term progress in disease control and production improvement.