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 Johnes disease (Mycobacterium paratuberculosis) and caseous lymphadenitis (CLA, Corynebacterium pseudotuberculosis). Removal kids from the kidding/maternity pen environment would reduce potential exposure to 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 CLA, while premises hygiene, vaccination and isolation of affected animals will be main strategies used to control of CLA in heavily infected herds. Integrated approaches to control of the chronic infectious diseases acquired early in life can greatly enhance longevity of goats in the herd.

STRATEGIES FOR APPROACHING INFECTIOUS DISEASE

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 life-long, and ability to categorize goats by disease status and trace risk to the post-natal environment are key to success in infectious disease control.

Are the goats co-mingled or share risk of exposure with other species? Scrapie and caseous lymphadenitis are shared between sheep and goats. Johnes 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 own 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.

CASEOUS LYMPHADENITIS (CONTAGIOUS ABSCESSES, CLA)

Abscesses caused by Corynebacterium pseudotuberculosis result from life-long infection with reoccurring abscesses of the regional lymph nodes. Draining of external abscesses result 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 imposed 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 CLA, while premises hygiene, vaccination and isolation of affected animals will be main strategies used to control of CLA 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 an isolation environment and preventing cross-contamination of premises and potential fomites are keys to successful management. Fly control will aid in 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 CLA vaccine 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.

CAPRINE ARTHRITIS ENCEPHALITIS VIRUS (CAEV) INFECTION

Caprine arthritis-encephalitis virus infection is a life-long lentivirus infection affecting monocytes and macrophages. The major route of transmission is via colostrums 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 polyarthritis 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 colostrums 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 56 C has been shown to prevent transmission of CAEV or Mycoplasma spp. to kids. Colostrum can be heated in a double boiler or water bath to 56 C and held in a preheated thermos bottle or 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 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 74 C (165 F) 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 transmisson 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.
RECOMMENDATIONS FOR 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 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 dehorning instruments without taking measures to eliminate virus and virus-infected cellular debris.

MYCOPLASMA MYCOIDES spp CAPRI AND MYCOPLASMA PUTRICFACIENS INFECTIONS

Mycoplasma mycoides spp capri (formerly Mycoplasma mycoides ssp 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 goats 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 1 lactation and infection of kids occurring during the subsequent lactation. Antibiotic treatment of goats infected with
**Mycoplasma mycoides spp capri** is unrewarding, recovered animals are usually intermittent shedders of mycoplasma throughout their life.

**Mycoplasma putrefaciens** - This mycoplasma is generally implicated in outbreaks of a highly contagious mastitis characterized by a fibrino-purulent odoriferous exudate and sudden agalactia. Does may shed the organism for 3-10 days prior to the onset of clinical signs. Increased CMT or SCC without clinical mastitis may be the first sign of infection. The infection is thought to be self-limiting in many cases and the organism is cleared from the mammary gland in about three weeks with return to normal milk production in 3-4 months. Clinical illness (fever and anorexia) associated with *Mycoplasma 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 *Mycoplasma putrefaciens* is based on identification of the organism and instituting strict milking sanitation procedures as described below for *Mycoplasma mycoides spp mycoides*. 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 goatcolostrum or milk. Complete cleaning and sanitation of the milking system is essential or there will be viable organism present at the next milking. Antibiotics may decrease the period of shedding but do not change the disease course and pose problems with milk withdrawal. Routine culturing of bulk tank milk will help to prevent explosive uncontrollable outbreaks of mastitis. Dairies with outbreaks may have 1/4-1/3 amount of usual milk to ship for 3-4 months.

**Mycoplasma agalactiae and Mycoplasma californicum** have been isolated from clinical mycoplasma mastitis cases, although there are no recent reports of *M. agalactiae* in the U.S. Control measures are the same as those recommended for *Mycoplasma mycoides spp capri*.

**RECOMMENDATIONS FOR CONTROL OF MYCOPLASMA INFECTIONS IN GOAT HERDS**

Pasteurized kid rearing programs used as the basis for CAEV control programs are the cornerstone of Mycoplasma prevention programs. Additional considerations for preventing mycoplasma transmission include: **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 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 2-6 weeks bimonthly milk cultures are taken until new cases are not detected for 2 culture periods, then monthly samples for 2-3 months followed by string pooled samples for 6 months. Dairies should have weekly samples frozen from the tank for routine monitoring and increase in SCC or increase in 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 and pasteurized goat, cows 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 (2) 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.

**JOHNES DISEASE RISK REDUCTION**

Johnes 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* subspp *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 Johnes cases is often observed. Johnes risk assessment in the herd should include cattle, sheep and other Johnes-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 U.S., 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. The herd health plan should include necropsy of all animals with chronic wasting and/or progressive neurologic signs.

**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 colostrums source are needed as part of the permanent doe record.

Planned routine necropsy of selective herd culls and 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. Johnes, scrapie, CLA, CAEV, mycoplasma can all be monitored by necropsy even though the cause of death may be unrelated to these diseases.

Serologic testing for CLA 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.

**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 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.

**REFERENCES** are available upon request from the author.