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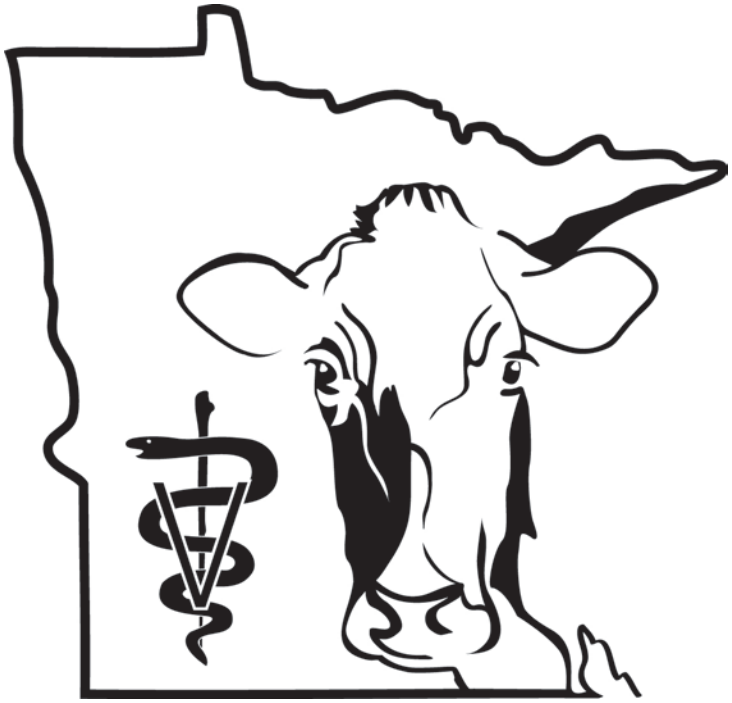

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MASTITIS AND THE DRY COW

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The dry period is a critical stage in the lactation cycle of the dairy cow. Several key aspects of cow health and productivity in the ensuing lactation are directly related to the duration and nutrition of this period, including: production, fetal development, and incidence of metabolic disease. Despite the cessation of lactation, the dry period is also a very dynamic period for the mammary gland, with dramatic involution of the gland parenchyma followed by new growth and development of lobulo-alveolar tissue before parturition. Mammary gland resistance to infection also is altered as leukocyte populations, composition of secretions, and teat canal structure all change dramatically. Therefore, the incidence of new intramammary infections (IMI) and clinical mastitis cases in the lactating cow is also dependent on the management of udder health during the dry period. Veterinary practitioners can use the dry period as a critical control point to be included as part of their dairy client's program of mastitis control. It will be the purpose of this paper to discuss some important aspects of dry cow management as it affects quality milk.

Dry Cow Treatment: Dry cow therapy has been promoted as an integral part of a mastitis control program for a quarter of a century,[7] especially as part of a control program for the contagious pathogens, *Streptococcus agalactiae* and *Staphylococcus aureus*. Although new infections caused by these organisms during the dry period may be prevented, the major benefit is believed to be the elimination of existing infections. Additionally, dry cow therapy has the advantage of not resulting in milk withdrawal periods after treatment if labelled instructions are

followed. As with lactating cow therapy, cure rates (those infections that existed prior to the dry period, but were not detected following calving) for *Str agalactiae* intramammary infections (IMI) are very high, probably >85 % in most herds. Thus, therapy continues to play an integral part in eliminating existing *Str agalactiae* infections.

Although culling is perhaps the most effective method of eliminating existing *S aureus* infections in a dairy herd, therapy can contribute to the elimination of *S aureus* IMI. However, this can be difficult because this organism can resist antimicrobial agents (β-lactamase, L-forms) and has the ability to survive in the presence of a hostile host immune system. Consequently, studies of treatment efficacy of *S aureus* mastitis have indicated cure rates of 25 to 55% of infected quarters in experimental and natural infections.[8,10,17]

The success of therapy for *S aureus* IMI is considered to be greater for dry cow as opposed to lactating cow treatment. On average, initial studies determined cures of 75% for infected quarters, and where comparisons were made, infected quarters receiving dry cow treatment were higher as compared to non-treated quarters.[1,7,11,12] However, this success may not reflect the true therapeutic benefit in all herds. A recent study by Soback et al[14] determined that cure rates for quarters treated with intramammary cephapirin (30.8%) did not differ from cows receiving no dry cow treatment (33.3%). Additionally, Cummins, et al[2] determined treatment of cows with cloxacillin at dry off, or a second treatment 2 weeks after drying off did not result in a better cure rate for *S aureus* infections than cows receiving no treatment. Possibly, more recent studies have reported poorer therapeutic efficacy as a result of developing bacterial resistance to antimicrobials. However, Mackie, et al[5] determined that the percentage of *S aureus* mastitis isolates sensitive in vitro to commonly used antimicrobials did not decrease from 1984-1987, and in this and another recent study, > 85% of *S aureus* isolates were sensitive to antimicrobials that did not have a structure susceptible to β-lactamase.[5,6]

Newbould reported that recurrences of isolation of bacteria following treatment of *S aureus* infections in lactating cows can occur up to 28 days, and therefore recommended a minimum period of 3 weeks after treatment and preferably 30 days of no bacterial isolation as a criterion

for cure.[8] Additionally, isolation of *S aureus* from milk samples by routine bacteriologic methods can be erratic. The sensitivity of a 0.1 ml inoculum of a single quarter milk sample to determine the presence of infection was reported as 74.5%, but increased to 94% and 98% by including a second and third sample, respectively.[13] Consequently, herd monitoring plans that attempt to detect *S aureus* IMI based on one sampling, particularly in the first 30 days after treatment may be offering a false sense of therapeutic success.

The pathologic changes associated with infection cause much of the difficulty in treatment of *S aureus* intramammary infections. This is supported by Newbould who determined that quarter cure rates decreased from 87.5 to 62.5% as the duration of infection increased from 3 to 60 days for experimental infections.[8] Therefore, it is questionable if intramammary therapy alone can affect a cure for long term infections, and many of the commercially available products are not the best choices from a pharmacologic standpoint to achieve effective concentrations in the abscess environment of chronic infections. Owens et al.[10] reported the combined use of intramuscular procaine penicillin G and intramammary amoxicillin achieved a better cure rate (18/35 infected quarters) than intramammary amoxicillin did alone (10/40 infected quarters) for experimental *S aureus* infections. Similarly, Soback et al.[14] determined that subcutaneous norfloxacin nicotinate administered at the start of the dry period achieved better cure rates for *S aureus* infections, as compared to untreated cows, or cows administered intramammary cephapirin benzathine preparations. Intramuscular oxytetracycline did not achieve a better cure rate, but did prevent new infections during the dry period better than cephapirin or no treatment.[14]

In a recently completed study, we attempted to determine the possible benefits of systemic oxytetracycline as an adjunct dry cow therapy to intramammary benzathine cephapirin. We chose this treatment because a majority of *S aureus* isolates are sensitive to tetracyclines in vitro[5,6], the lipophilic nature and relatively long half-life of oxytetracycline should allow effective concentrations in mammary tissue[18], tetracyclines are not detrimental to in vitro neutrophil phagocytosis or viability[4,9], and oxytetracycline is commercially available for non-lactating cows, although not approved for mastitis. Additionally, Sol et al[15] determined that 5 mg/lb of oxytetracycline administered in conjunction with a commercial intramammary antibiotic

improved the cure rate of *S aureus* infections in lactating cows. We divided *S aureus* infected cows into two treatment groups: one group receiving 300 mg of benzathine cephapirin in each quarter at dry off, and the second group cephapirin as well intramuscular oxytetracycline. Oxytetracycline was dosed at 5 mg/lb once a day for four days (total dose of 20 mg/lb) starting one week after dry off. Cows were quarter sampled three weeks and one week before dry off, and at dry off. Quarter samples were again collected at one, two and four weeks after calving. Each sample was refrigerated and plated within 24 hours after collection, and then frozen. After 24 to 72 hrs, the frozen samples were thawed and replated. For the purpose of this trial, we defined an infected quarter before dry off whenever *S aureus* was isolated from both the fresh and frozen culture, from any one sample. We defined a cure if an infected quarter was positive before dry off, but did not have a positive isolation on both the fresh and frozen culture from any sampling after calving. Tables 1 and 2 summarize the results of this trial with two important points: 1) systemic treatment was not beneficial in curing IMI, and 2) if quarters are monitored for 60 days rather than 30 days, apparent cure rates decline.[3]

Thus, while very successful in the control of IMI caused by Str agalactiae, dry cow therapy has variable results for IMI caused by S aureus. Due to the difficulties in achieving therapeutic success with IMI caused by S aureus, alternative therapeutic strategies may need to be employed, however success will vary from herd to herd and careful monitoring should be employed to insure that the any therapeutic success is actual and not perceived.

Dry cow therapy and environmental mastitis

Herds that have controlled contagious mastitis frequently question the continued use of dry cow treatment. This is best decided on an individual herd basis, however research indicates that at least 50 % of the clinical mastitis cases caused by streptococci (other than agalactiae) result from infections that started during the dry period, particularly the early dry period. Additionally, the rate (cows infected/day) of new streptococcal IMI during the dry period is 6 times higher than during lactation, although many infections spontaneously cure.[16] Studies have consistently demonstrated cure rates of streptococcal IMI during the dry period improve, and new infections rates decrease as a result of antimicrobial therapy. Dry cow therapy may also be advantageous for staphylococcal (other than *aureus*) IMI. Dry cow therapy is not likely to

have much benefit for IMI caused by Gram negative rods, particularly those that occur as new IMI in the peri-parturient period, typical of IMI caused by *Escherichia coli. Therefore, it is recommended that dry cow therapy be continued in most herds, despite the lack of contagious organisms. Where herd data indicates that strep and staph IMI are not a problem associated with the dry period, dry cow therapy may not be cost-effective. In all cases when dry cow therapy is employed, strict aseptic preparation of the teat end and partial insertion of the cannula into the teat canal should be performed.*

Dry Cows and Mastitis: Beyond Therapy

It is becoming apparent that too often we as veterinarians have overlooked dry cow management as a critical part of mastitis control. Historically, much of the focus of mastitis control was dedicated to lactating cows, which is appropriate for contagious pathogens. However, as the needs and concerns for environmental mastitis control increase, emphasis on dry cow management is increasing. Bedding, type of housing, cow comfort, vaccinations, and nutrition of the dry cows have all been demonstrated to affect environmental IMI, and clinical mastitis cases in the ensuing lactation. Some key points to consider:

1) Use inorganic bedding for dry cows and maternity pens whenever possible. Sand in free stalls is an excellent choice. Problems with manure handling systems may make this unfeasible in some herds, however, mattresses are another possibility. Maternity pens should be clean, dry, and comfortable, just like the rest of the herd.

2) In herds with recorded coliform mastitis problems, consider use of core antigen (J-5) vaccines. Although reduction in the incidence of clinical cases due to coliform mastitis is possible, the best benefit may be a reduction in the severity of infection. Some debate occurs over two vs three immunizations during the dry period, three immunizations being more labor intensive. However, the predominance of field research that has demonstrated vaccine success in reducing coliform mastitis losses has resulted from trials using three vaccination regimens. The best indicator to determine the plan for a herd would be to monitor the success of the program if 2 immunizations are used, success being monitored by clinical mastitis records of the lactating cows. If less than desirable results are obtained, consider three immunizations.

3) Maintain dry cows on a good nutritional plane. This includes avoidance of post-partum metabolic diseases through a sound transitional feeding program, as well as a separate, balanced dry cow ration. Particular attention should be paid to the selenium and vitamin E status as these micronutrients are frequently fed at below optimum levels in dry cows and heifers. As more herds orientate their management to confinement and ensiled feeds, this is likely to compound the problem. Recent research has indicated that heifers may be susceptible to marginal copper deficiencies, and that copper has a positive impact on mammary resistance to disease.

Summary

In most herds, dry cow therapy should remain as an integral part of the herd program. With respect to therapy however, other aspects of dry cow management is often overlooked as a part of a dairy herd's mastitis control program. Thus, veterinarians should include an active awareness of dry cow management as part of their client's mastitis control program. Ironically, the best measure of success in many herds is to monitor the clinical mastitis incidence of cows in the early lactation period. As environmental mastitis becomes the predominant mastitis problem in many herds, this is the type of monitoring that will need to be included in a total herd health program.

Table 1- Efficacy of systemic oxytetracycline as an adjunct dry cow therapy for intramammary *Staphylococcus aureus* infections- monitored for 30 days after calving.

	Oxytet + Ceph	**Cephapirin**	**TOTAL**
Quarters cured	10/34 (29.4%)	11/40 (27.5%)	21/74 (28.4%)
Cows cured	5/17 (29.4%)	5/20 (25.0%)	10/37 (27.0%)

Table 2- Efficacy of systemic oxytetracycline as an adjunct dry cow therapy for intramammary *Staphylococcus aureus* infections- monitored for 60 days after calving.

	Oxytet + Ceph	**Cephapirin**	**TOTAL**
Quarters cured	7/33 (21.2%)	9/40 (22.5%)	16/73 (21.9%)
Cows cured	2/16 (12.5%)	3/20 (15.0%)	5/36 (13.9%)

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