ABSTRACT

Efficacy of premilking teat disinfection (predipping) with good udder preparation was compared with good udder preparation alone on four well-managed, commercial dairy farms. Three teat dip formulations containing iodophor were used for predipping. Predipping reduced the rate of intramammary infection with major mastitis pathogens approximately 54%. Infection rate with esculin-positive streptococci and coliforms was reduced more than 51%. Udder infections with coagulase-negative staphylococci were not controlled by predipping.

INTRODUCTION

Prevention of mastitis by teat disinfection was reviewed in 1965 by Newbould (7). Major emphasis was to control udder infections by Staphylococcus aureus and Streptococcus agalactiae. Infected udders were recognized as the main reservoir of both Staph. aureus and Strept. agalactiae. These pathogens were transmitted by hands and milking equipment. Number of new intramammary infections (IMI) caused by Staph. aureus and Strept. agalactiae was reduced significantly by disinfection of teat skin, milking equipment, and milkers hands (7).

Neave et al. (5) determined that incidence of IMI was correlated to the number of mastitis pathogens on the teat end. Field studies determined that postmilking teat disinfection significantly reduced infection rate (6).

Results from numerous experimental and natural exposure studies indicated that many teat dip formulations reduced infection rate compared with no postmilking teat sanitation. Staphylococcus aureus and Strept. agalactiae are considered to be contagious forms of mastitis and are controlled most effectively by postmilking teat sanitation (4, 6, 8).

Control of mastitis caused by environmental pathogens, esculin-positive streptococci (EPS), and coliforms (CO) was not as evident by postmilking teat sanitation (1, 9). Factors currently considered important in the control of mastitis caused by environmental pathogens include management and increased resistance of cows (9). One recommended approach to control was decreased exposure of teat ends to environmental pathogens.

Premilking udder preparation methods were evaluated by Galton et al. (2). Lowest bacterial counts were obtained when teats were cleaned with a water hose or wet towel or when a premilking disinfectant teat dip followed by drying with paper towels was used.

Residues of sanitizers due to premilking udder preparation were studied by Galton et al. (2). Thorough drying of teats with paper towels after dipping with an iodophor sanitizer was necessary to reduce iodine residues in milk. Use of a .5% iodophor sanitizer caused less iodine residue in milk than a 1% iodophor. In the evaluation of udder hygiene, premilking teat sanitation (predipping) developed as another possible method to control the incidence of environmental mastitis; number of these pathogens could be decreased immediately prior to milking by use of iodophor germicides at concentrations from .1 to .5%.

Objective of this field study was to determine the effect of predipping with good udder preparation on incidence of new IMI compared with good udder preparation alone.

MATERIALS AND METHODS

Cooperator Herds

Four commercial dairy herds met the following criteria: 1) all lactating cows had
permanent, visible identification, 2) herds were on the Dairy Herd Improvement Program, 3) all milking management practices and milking equipment met standards recommended by the National Mastitis Council (3), and 4) all quarters of all cows were treated at drying off with a commercial product.

Management practices met or exceeded current recommended methods for all four herds (Table 1). Infection with major pathogens was less than 10% of cows for each herd at initiation of this study. Bulk tank milk somatic cell counts were consistently below $4 \times 10^5$/ml and standard plate counts were routinely below $1 \times 10^3$ cfu/ml. The study was conducted on herds A, B, and C for approximately 12 mo and herd D for 6 mo.

### Treatment Groups

A split herd design was used in all four herds. Cows were identified by treatment with either white or yellow leg bands placed on one of the hind legs. Each herd was divided equally, within practical limits, based on lactation number, bacteriological status of quarters, and stage of lactation. Cows entering the herd were alternately assigned to one of two treatment groups: group 1 (Predip) = good udder preparation prior to milking with premilking and postmilking teat antisepsis; group 2 (Control) = good udder preparation prior to milking and postmilking teat antisepsis. Good premilking udder preparation included: 1) teats and base of udder were washed with paper towel wet with germicidal udder wash (approximately 50 ppm iodine); 2) forestripping; 3) teats of cows in predip group were immersed in one of the germicidal products, with minimum contact time of 30 s; and 4) teats of both groups were dried thoroughly with individual paper towels. Cows in predip and control groups were milked in a routine manner. All teats were immersed in germicidal teat dip after machine removal. The same germicidal teat sanitizer was used as predip and postdip within a herd (Table 1).

### Table 1. Information on cooperator herds at initiation of study.

<table>
<thead>
<tr>
<th>Herd</th>
<th>No. cows</th>
<th>Eligible quarters</th>
<th>Germicide</th>
<th>Average bulk milk analysis</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SCC ($\times 10^3$)</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>84</td>
<td>271</td>
<td>1</td>
<td>250 1–8</td>
<td>F^4</td>
</tr>
<tr>
<td>B</td>
<td>52</td>
<td>176</td>
<td>1</td>
<td>410 4–12</td>
<td>T^5</td>
</tr>
<tr>
<td>C</td>
<td>85</td>
<td>274</td>
<td>2</td>
<td>350 2–10</td>
<td>F</td>
</tr>
<tr>
<td>D</td>
<td>115</td>
<td>451</td>
<td>3</td>
<td>335 1–8</td>
<td>F</td>
</tr>
</tbody>
</table>

1 = .25% iodophor, Bovadine II, West Agro Chemical Inc. Kansas City, MO; 2 = .55% iodophor-1.9% linear-dodecyl benzene sulfonic acid, Tandem, IBA, Inc., Milbury, MA; 3 = .1% iodophor, Pre-Vail, IBA, Inc., Milbury, MA.


2 SCC = Somatic cell count.

3 SPC = Standard plate count.

^4 F = Freestall.

^5 T = Tie stall.
Collection of Milk Samples

All quarter milk samples were collected aseptically in duplicate (3). Milk samples were collected by university staff at initiation of the study to determine bacteriological status of individual quarters. Quarter milk samples were collected bimonthly throughout the study to monitor IMI. Herd owners collected quarter milk samples from cows at drying off, at first milking after calving, and from all quarters of cows that developed clinical mastitis prior to infusion of antibiotics. Farmer-collected samples were stored frozen and collected approximately every 2 wk by laboratory personnel.

Analysis of Milk Samples

Bacteriological analysis was conducted on all quarter milk samples on tryptose blood agar (TBA) that contained .1% esculin (3). A .01-ml aliquot of each quarter sample was streaked on one quadrant of a TBA plate. Milk samples from clinical cases were thawed at room temperature and cultured on a TBA plate and a MacConkey agar plate. In addition, a .1-ml aliquot was smear-plated on one-half of a TBA and a MacConkey agar plate.

An IMI was diagnosed by one of the following criteria: 1) isolation of >100 cfu/ml of a pathogen from a clinical sample, 2) isolation of >500 cfu/ml of a pathogen from two consecutive samples, 3) isolation of <400 cfu/ml of a pathogen from three consecutive samples, 4) clinical cases with abnormal milk that were bacteriological negative for each of the duplicate milk samples.

Data Analysis

Infection data were analyzed based on percent eligible quarters becoming infected.

The following statistic was applied (8):

\[ t = \frac{(P_1 - P_2)}{(\frac{P_1 Q_1}{N_1}) + (\frac{P_2 Q_2}{N_2})^{.5}} \]

where t approximates a Student's statistic, P is percent quarters becoming infected, Q is percent quarters not becoming infected, N is number of eligible quarters and, subscripts refer to treatment groups.

### Table 2. New intramammary infections in predip evaluation of 25% iodophor in herd A.

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of eligible quarters</th>
<th>Infected quarters</th>
<th>Total Environmen</th>
<th>Major^1</th>
<th>Major^2</th>
<th>Reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predip</td>
<td>149</td>
<td>0</td>
<td>7</td>
<td>24</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Control</td>
<td>122</td>
<td>3</td>
<td>10</td>
<td>11</td>
<td>1</td>
<td>16</td>
</tr>
</tbody>
</table>

^1 | Staphylococcus aureus
^2 | coagulase-negative staphylococci (minor pathogens), EPS = esculin-positive staphylococci, CM = coliforms, CM Neg = clinical mastitis, bacteriologically negative, Qtr = quarter.

\[ a < 0.025, \quad b < 0.05 \]

Journal of Dairy Science Vol. 70, No. 4, 1987
RESULTS AND DISCUSSION

Intramammary infection data for individual herds are in Tables 2 to 5. Rate of IMI by major mastitis pathogens was reduced significantly by predipping with good udder preparation compared with good udder preparation alone. The three germicidal products were equally effective across the four herds. Percent reduction ranged from 45.3 to 61.5% for all major pathogens.

Many IMI diagnosed were in the clinical state and bacteriologically positive. In the predip treatment group, 52% of all IMI were clinical cases; 51% of IMI with environmental pathogens were clinical. In the control group, 45% of all IMI with major pathogens and 50% of IMI with environmental pathogens were considered clinical cases.

Many EPS or CO infections were diagnosed in the clinical state. Fifty percent of the EPS were clinical cases in the predip group and only 26% of the IMI in the control group were clinical. For CO infections, 52 and 68% of the IMI in predip and control groups were clinical. Incidence of clinical cases among environmental infections is in the range reported in (9). No explanation is offered for the large difference between incidence of clinical cases in the predip and control groups for EPS. Incidence of clinical mastitis was higher in dipped quarters than in undipped quarters in experimental challenge studies for Strep. agalactiae and Staph. aureus (8). Effects of germicidal teat dips on virulence of organisms has not been determined.

Rate of IMI with coagulase-negative staphylococci (CNS) was not reduced by predipping. A total of 71 CNS infections were diagnosed in cows predipped and 59 among controls. Controlled studies are needed on the epidemiology of CNS in bovine mastitis.

Predipping reduced IMI with environmental pathogens in each herd. Reduction in IMI with environmental pathogens ranged from 47% to 56%. Infection data for environmental pathogens are in Table 6 for all four herds. Rate of IMI for environmental pathogens was reduced 51.5% (P<.001). A reduction in IMI of 48.2% (P<.025) was determined for EPS and a 54% reduction (P<.005) was observed for CO IMI.

These data indicate that predipping with good udder preparation effectively reduced rate of IMI by environmental mastitis pathogens over good udder preparation alone. Postmilking...
### TABLE 4. New intramammary infections in predip evaluation of 1.9% LDBSA4/.55% iodophor in Herd C.

<table>
<thead>
<tr>
<th>Group</th>
<th>Number eligible quarters</th>
<th>Infected quarters</th>
<th>Total</th>
<th>Major Qtr Reduction</th>
<th>Env Qtr Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predip</td>
<td>137</td>
<td>3</td>
<td>28</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Control</td>
<td>137</td>
<td>4</td>
<td>26</td>
<td>2</td>
<td>7</td>
</tr>
</tbody>
</table>

Major pathogens = SA, EPS, CO.  
Environmental pathogens = EPS, CO.

LDBSA = Linear dodecyl benzene sulfonic acid.

### TABLE 5. New intramammary infections in predip evaluations of .1% iodophor in Herd D.

<table>
<thead>
<tr>
<th>Group</th>
<th>Number eligible quarters</th>
<th>Infected quarters</th>
<th>Total</th>
<th>Major Qtr Reduction</th>
<th>Env Qtr Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predip</td>
<td>239</td>
<td>3</td>
<td>12</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Control</td>
<td>212</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

Major pathogens = SA, AG, EPS, CO.  
Environmental pathogens = EPS, CO.

SA = Staphylococcus aureus, CNS = coagulase-negative staphylococci (minor pathogens), EPS = esculin-positive streptococci, CO = coliforms, CM neg = clinical mastitis, bacteriologically negative.

**P<.05.**
TABLE 6. Summary of new intramammary infections with environmental pathogens in predip studies in four commercial farms.

<table>
<thead>
<tr>
<th>Group</th>
<th>Number eligible quarters</th>
<th>Infected quarters</th>
<th>Qtr</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>EPS(^1) (no.)</td>
<td></td>
<td>(%)</td>
</tr>
<tr>
<td>Predip</td>
<td>619</td>
<td>18(^2)</td>
<td>39</td>
<td>6.3</td>
</tr>
<tr>
<td>Control</td>
<td>553</td>
<td>31</td>
<td>41</td>
<td>13.0</td>
</tr>
</tbody>
</table>

\(^1\)EPS = Esculin-positive streptococci, CO = coliforms.

\(^2\)48.2% reduction (P<.025).

\(^3\)54.0% reduction (P<.005).

teat antisepsis was practiced in both treatment groups.

Data from this study suggest that the environmental pathogens, EPS and CO, cause new infections during milking. The inference is that the number of environmental pathogens (EPS and CO) on teats prior to milking is reduced significantly by predipping with an effective germicide, and consequently, the rate of new infections is reduced. It appears that environmental pathogens contaminate teat skin between milkings but may or may not cause new infections between milkings. Further studies are needed to determine when infections by specific environmental pathogens occur and how premilking teat sanitation reduces the rate of new infections.

ACKNOWLEDGMENTS

Authors express appreciation to the four cooperator herds for their patience and understanding during the course of this study: Hatch Bros Dairy, Whitney’s Oughta-Be Farm, David Russell Dairy, and Audet’s Blue Spruce Farm. The support of this project by West Agro, Inc. and IBA, Inc. is gratefully acknowledged.

REFERENCES


