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Bovine Mastitis Pathogens in New York and Pennsylvania: Prevalence and Effects on Somatic Cell Count and Milk Production

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ABSTRACT

Milk samples were collected from 108,312 dairy cows during 1601 farm visits made between January 1991 and June 1995. The herd visits were made by personnel from the Central Laboratory of the Quality Milk Promotion Services at Cornell University (Ithaca, NY) to farms located in central New York and northern Pennsylvania. Dairy Herd Improvement Association records were available for 32,978 cows in 327 herds. Intramammary infections, as defined by positive milk cultures, were present in 48.5% of all cows and in 36.3% of cows in herds enrolled in the Dairy Herd Improvement Association. Over 75% of the intramammary infections were caused by *Streptococcus agalactiae*, *Streptococcus* spp. other than *Strep. agalactiae*, *Staphylococcus aureus*, and coagulase-negative staphylococci. Mean days in milk at the time of diagnosis, linear score of the somatic cell count, cost of milk loss per lactation, and milk production effects were calculated for 24 etiologic agents of bovine mastitis.
(**Key words**: mastitis pathogens, mastitis prevalence, somatic cell count, milk production)

Abbreviation key: **LS** = linear score of the SCC, **305ME** = 305-d mature equivalent milk production, **QMPS** = Quality Milk Promotion Services.

INTRODUCTION

Information regarding the prevalence of mastitis pathogens and the costs associated with different bacterial infections is of interest to the dairy industry. The relative importance of mastitis agents and evaluation of whether DHIA record use is associated with the prevalence of mastitis helps prioritize mastitis control efforts. No widespread surveys of large numbers of dairy farms have reported on the prevalence and financial effects of bovine mastitis in the US for >10 yr. The Central Laboratory of the Quality Milk Promotion Services (**QMPS**) at Cornell University (Ithaca, NY) performs work pertaining to mastitis diagnosis and prevention for herds located in central New York and parts of northern Pennsylvania. The majority of herds (70%) use this service as a monitoring procedure once or twice per year, and 30% do so in response to bulk milk SCC that are >750,000/ml. This retrospective study utilized data from herd visits and culture results as well as DHIA information to estimate the prevalence and financial impact of mastitis pathogens.

MATERIALS AND METHODS

A total of 1601 dairy herd visits to monitor mastitis and management practices were performed by the Central Laboratory of the QMPS from January 1991 to June 1995. Composite milk samples were aseptically collected by QMPS personnel from all lactating cows in 96.7% of the herds, and, in the remaining herds, milk samples were collected from cows with a DHIA linear score of the SCC (**LS**) >4.5. Whether dairy herds used this service as a result of bulk tank milk SCC >750,000/ml (a violation of legal standards) or to maintain or improve milk quality was recorded for all herd visits.

The IMI were defined by isolation of mastitis pathogens from composite milk samples. For isolation of mycoplasma, 0.1 ml of each milk sample was streaked on one-half of modified Hayflick medium (12). Plates were incubated, and isolates were identified as described previously (14). To isolate the remaining mastitis agents, 0.01 ml of each milk sample was streaked on trypticase soy agar containing 5% sheep blood and 0.1% esculin (Crane Laboratories, Syracuse, NY). Blood agar plates were incubated aerobically at 37°C for 48 h. After observation of colony morphology and hemolytic patterns on blood agar, isolates were examined further by means of 3% KOH, Gram staining of organisms, catalase and oxidase testing, and additional biochemical and metabolic evaluations as needed. Gram-negative organisms were identified by colony morphology on MacConkey's agar, motility, indole production, lysine

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decarboxylation, urease production, citrate utilization, acetyl-methylcarbinol production, and acid production from adonitol and raffinose. *Streptococcus* spp. that had a positive CAMP reaction and did not hydrolyze esculin were classified as *Streptococcus agalactiae*; the remainder were classified as *Streptococcus* spp. other than *Strep. agalactiae*. *Staphylococcus* spp. with typical zones of complete and incomplete hemolysis and nonhemolytic *Staphylococcus* spp. that had a positive tube test for free coagulase were classified as *Staphylococcus aureus*; other staphylococci were classified as coagulase-negative staphylococci (*Staphylococcus* spp.).

Prototheca spp. and yeast were identified as previously described (13). Other organisms were identified following recommended procedures (5,6). Isolation of three or more types of bacteria was defined as contamination; however, isolates of *Strep. agalactiae*, *Staph. aureus*, or *Mycoplasma* spp. were always defined as IMI. A cow was eligible to have >1 case of mastitis from the same composite milk sample. Multiple isolates were counted as one mastitis case caused by each different pathogen. Contaminated cases were excluded from analysis. Culture results were combined with data from the Northeast DHIA (Ithaca, NY).

Using QMPS data and DHIA information, prevalence of each pathogen among all cows and among DHIA cows was calculated. For cows with DHIA records, DIM at the time of detection, LS for the month when mastitis was detected, LS from the previous month, dollar loss per lactation, and 305-d mature equivalent age-, season-, and fat-corrected milk production (**305ME**) were calculated for all cows and for each mastitis pathogen. Two forms of dollar loss estimates were compared. One estimate used DHIA projections of milk production loss per lactation based on LS and valued milk at $13.00/cwt of milk [e.g., LS = 5.0 to 5.9; 545 kg (1200 lb) of milk loss × $13.00/cwt = $156.00 loss per lactation]. The other method used compared mean DHIA 305ME for cows infected with each pathogen with that for uninfected cows (as determined by negative cultures). The milk production difference was valued at $13.00/cwt.

RESULTS

Milk samples were collected from 108,312 cows, 32,978 of which had DHIA records. Mean herd size was 69.8 lactating cows. Farms using QMPS to monitor or to improve milk quality constituted 70% of the farms, and 30% of the farms used QMPS because the bulk milk SCC exceeded the legal limit of 750,000/ml. Culture results from 3229 cows were excluded from analysis because they were determined to be contaminated; 1510 of these culture results were from cows with DHIA records. Prevalence of IMI was 48.5% (n = 50,926 of 105,083) among all cows. For DHIA cows, prevalence of IMI was 36.3% (n = 11,410 of 31,468). The most prevalent mastitis agents among all cows were *Staphylococcus* spp., 11.3% (n = 11,825); *Strep. agalactiae*, 10.1% (n = 10,648); *Staph. aureus*, 9.1% (n = 9531); *Streptococcus* spp. other than *Strep. agalactiae*, 7.3% (n = 7646); and *Corynebacterium bovis*, 7.2% (n = 7564) (Table 1). Coliforms accounted for 0.6% of the IMI, and *Escherichia coli* (0.4%) and *Klebsiella* spp. (0.2%) accounted for nearly all coliform cases (Table 1).

Mean LS during the month that IMI were detected for the 27,648 cows with DHIA LS records was 3.5. Mean LS for mastitic cows was 4.4, and mean LS for uninfected cows (negative cultures) was 3.0 (Table 2). For the current lactation, mean LS was 3.4 for all cows, 4.1 for cows with IMI, and 2.9 for uninfected cows (Table 2). Financial losses per case using 305ME and LS, respectively, were $127.53 and $147.63 for cows with IMI and $0.00 and $115.35 for uninfected cows (Table 3). Milk production was lower for mastitic cows; 305ME was 9405 kg (20,690 lb) for all cows with DHIA records, 9578 kg (21,071 lb) for uninfected cows, and 9132 kg (20,090 lb) for infected cows (Table 4).

All data are presented in Tables 1 through 4. Results and discussion are presented here for mastitis pathogens for which observations numbered ≥10. The LS at the time of detection was highest for *Strep. agalactiae* (5.6), *Pasteurella* spp. (6.3), Group G streptococci (6.2), *Serratia* spp. (6.1), *Mycoplasma* spp. (5.7), and *Klebsiella* spp. (5.7) (Table 2). Estimates of the dollar loss per case were generally higher when 305ME difference was used than when estimates were calculated based on LS (Table 3). Financial milk loss per lactation was highest for the following mastitis agents using either 305ME or LS, respectively: *Pasteurella* spp., $500.12 or $253.70; *Mycoplasma* spp. $451.63 or $229.89; *Strep. agalactiae*, $388.19 or $178.92; and *Arcanobacterium pyogenes*, $348.15 or $194.24. Of the most prevalent agents, *Staph. aureus* ($185.51; $160.52) and *Streptococcus* spp. ($143.65; $168.99) were also relatively costly (Table 3).

Mean DIM at the time of sampling was 179 for all cows (186 d for cows with positive cultures and 174 d for cows with negative cultures). Mean DIM at the time of detection of most mastitis agents was between 160 and 200 d. Intramammary infections caused by

TABLE 1. Prevalence among all cows and among DHIA cows for each agent.

Culture result	Prevalence			
	All		DHIA	
	(%)	(no. of cows)	(%)	(no. of cows)
All cows	100.0	105,083	100.0	31,468
Positive cultures	48.5	50,926	36.3	11,410
Negative cultures	51.5	54,157	63.7	20,058
Streptococcus agalactiae	10.1	10,648	4.7	1494
Streptococcus spp.	7.3	7646	6.0	1902
Staphylococcus aureus	9.1	9531	7.7	2440
Staphylococcus spp.	11.3	11,825	10.2	3211
Escherichia coli	0.4	407	0.4	120
Klebsiella spp.	0.2	173	0.2	49
Pseudomonas spp.	0.1	118	<0.1	14
Serratia spp.	0.1	93	0.1	29
Gram-negative bacilli	0.6	663	0.2	49
Yeast	0.1	142	0.1	41
Arcanobacterium pyogenes	0.3	367	0.4	116
Corynebacterium bovis	7.2	7564	5.0	1579
Gram-positive bacilli	0.8	835	0.2	79
Mycoplasma spp.	0.1	85	0.1	29
Group G streptococci	0.1	125	<0.1	14
Pasteurella spp.	<0.1	48	<0.1	14
Proteus spp.	0.3	296	0.3	87
Mold	0.3	341	0.2	68
Nocardia spp.	<0.1	5	<0.1	2
Prototheca spp.	0.1	128	0.1	28
Fungus	<0.1	22	0.1	3
Corynebacterium spp.	0.1	66	0.1	35
Enterobacter spp.	<0.1	15	<0.1	2
Citrobacter spp.	<0.1	11	<0.1	5

Mycoplasma spp. were detected at a mean 117 DIM, which was lower than that for other agents (Table 2).

Absolute milk production was higher for cows that were infected with *Nocardia* spp., *Corynebacterium* spp., *Klebsiella* spp., *Pseudomonas* spp., and *Staphylococcus* spp. [305ME >9545 kg (21,000 lb)] (Table 4). Most other mastitic cows produced >8664 kg (19,500 lb) of milk. Lowest 305ME was associated with mastitis caused by *Strep. agalactiae* (8220 kg; 18,085 lb), *Mycoplasma* spp. (7999 kg; 17,597 lb), and *Pasteurella* spp. (7829 kg; 17,224 lb) (Table 4).

DISCUSSION

Bovine mastitis, defined by isolation of etiologic agents, is relatively common, often more so than many producers realize. This representative sample of >100,000 cows from >1600 herd visits made over 4.5 yr suggested that the prevalence of mastitis was nearly 50% in New York and Penssylvania. The prevalence of mastitis for herds enrolled in DHIA was 36%, which suggests that the use of a dairy herd testing and monitoring program was associated with better management and control of mastitis. In comparison, a report from Finland (15) found a 37.8% prevalence of mastitis within 280 dairy herds during 1995, which had decreased since the 1940s. However, the same researchers (19) commented that mastitis had not greatly decreased in Finland over the last 50 yr.

Many estimates of the prevalence of mastitis in nations or regions were made during the 1970s to early 1980s. A study (27) using a stratified representative sample of 501 dairy herds in England in 1977 showed a 32.0% prevalence of streptococcal or staphylococcal mastitis, which indicated a 40 to 50% reduction in mastitis among English dairy cows since 1964. However, that survey (27) also found that 70.0% of English cows tested positive for *C. bovis*. The prevalence of mastitis in 25 dairy herds from one region of Australia was 63.4% during the mid 1970s (25). Another Australian study (20) of 35 dairy herds reported that the prevalence of mastitis caused only by *Staph. aureus*, *Strep. agalactiae*, and *Streptococcus* spp. totalled 34.0% in 1974. Mastitis within the same herds decreased to 15.8% when the herds were enrolled in a mastitis control program over the next 3 yr. A 1979 Ontario survey of 74 DHIA herds (4) found that 93.9% of cows tested positive for some type of bacteria in milk culture; pathogens other than *C. bovis* and *Staphylococcus* spp. were found in 31.7%

TABLE 2. Days in milk at the time of detection and linear scores of the SCC (LS) for cows infected with mastitis pathogens.

Culture result	DIM	(no. of cows)	LS	(no. of cows)	MLS[1]	(no. of cows)
All cows	179	31,468	3.5	27,648	3.4	27,945
Culture-positive	186	11,410	4.4	9879	4.1	10,000
Culture-negative	174	20,058	3.0	17,769	2.9	17,945
Streptococcus agalactiae	192	1494	5.6	1308	5.1	1297
Streptococcus spp.	179	1902	5.1	1643	4.8	1663
Staphylococcus aureus	187	2440	5.1	2076	4.6	2152
Staphylococcus spp.	187	3211	3.7	2819	3.5	2828
Escherichia coli	190	120	4.9	94	4.6	98
Klebsiella spp.	189	49	5.7	39	5.4	41
Pseudomonas spp.	201	14	5.5	12	5.0	12
Serratia spp.	227	29	6.1	20	5.2	20
Gram-negative bacilli	162	49	4.9	42	4.6	42
Yeast	148	41	4.8	33	4.6	34
Arcanobacterium pyogenes	165	116	5.3	85	4.9	87
Corynebacterium bovis	200	1579	3.9	1385	3.7	1398
Gram-positive bacilli	169	79	3.5	74	3.3	74
Mycoplasma spp.	117	29	5.7	24	5.4	28
Group G streptococci	163	14	6.2	14	5.6	14
Pasteurella spp.	193	14	6.3	10	6.4	12
Proteus spp.	190	87	4.9	73	4.6	71
Mold	173	68	3.4	55	3.1	55
Nocardia spp.	132	2	2.9	2	2.5	2
Prototheca spp.	169	28	5.4	28	5.2	28
Fungus	56	3	3.0	2	2.6	3
Corynebacterium spp.	224	35	3.5	35	3.5	35
Enterobacter spp.	348	2	8.2	1	7.9	1
Citrobacter spp.	172	5	4.5	5	4.5	5

[1]Mean LS for the current lactation.

of the cows, and *C. bovis*, *Staphylococcus* spp., or both were found in 53.1% (4). A report (22) of 34 selected Massachusetts dairy herds from 1976 to 1982 found the prevalence of major pathogens to be 42.4%, which did not include *Staphylococcus* spp.

In the present study, cases of staphylococcal and streptococcal mastitis (mastitis caused by *Strep. agalactiae*, *Streptococcus* spp., *Staph. aureus*, and *Staphylococcus* spp.) were most common; the prevalence was 38%, including >75% of all mastitis isolates. *Streptococcus agalactiae* and *Staph. aureus* were detected in 19% of the cows and had the greatest overall financial impact. These pathogens were found in only 12% of the DHIA cows, the greatest percentage of reduction associated with DHIA enrollment. Over time and in many locations, *Strep. agalactiae*, *Streptococcus* spp., *Staph aureus*, and *Staphylococcus* spp. have been consistently found to be the most frequently isolated mastitis agents. In Finland during the 1990s, *Staph. aureus* and *Staphylococcus* spp. were found in 26.5% of the cows sampled and constituted over 70% of all agents isolated (15). *Streptococcus agalactiae* has been nearly eradicated in Finland (19). The most common mastitis pathogens found in England were *C. bovis*, *Staph. aureus*, and *Strep. agalactiae* (27). Streptococcal and staphylococcal mastitis agents were found in 42.1% of Australian dairy cows, accounting for nearly 70% of all mastitis isolates (25). In Ontario, *C. bovis*, *Staphylococcus* spp., *Staph. aureus*, *Streptococcus* spp., and *Strep. agalactiae* were the most prevalent pathogens that caused mastitis, accounting for nearly all cases (4). A 1987 study of 32 DHIA herds in Pennsylvania (10) found that *C. bovis* (27.3%), *Staphylococcus* spp. (26.6%), *Strep. agalactiae* (25.6%), and *Staph. aureus* (12.0%) were the most prevalent mastitis agents.

The term major pathogen is often used concerning mastitis agents, but agreement is not universal (8, 11, 21) concerning which pathogens are the major pathogens. Usually, a combination of high prevalence, the contagious nature of the IMI, and costly effects per case determines which pathogens are considered the major mastitis pathogens. From this data file, there is evidence that the major pathogens are *Strep. agalactiae*, *Staph. aureus*, *Streptococcus* spp., and *Mycoplasma* spp.

Differences in milk production between cows with no detectable IMI and those with IMI were converted to an estimated dollar loss. Some bias may exist in

TABLE 3. Two methods to estimate dollars lost per lactation for cows infected with mastitis pathogens.

Culture result	305ME[1]		LS[2]	
	($)	(no. of cows)	($)	(no. of cows)
All cows	–49.53	29,504	–131.90	15,650
Culture-positive	–127.53	10,598	–147.63	7694
Culture-negative	0.00	18,906	–115.35	7956
Streptococcus agalactiae	–388.19	1345	–178.92	1182
Streptococcus spp.	–143.65	1763	–168.99	1397
Staphylococcus aureus	–185.51	2286	–160.52	1819
Staphylococcus spp.	+11.83	2996	–113.72	1825
Escherichia coli	–129.61	113	–160.49	81
Klebsiella spp.	+19.76	49	–184.89	36
Pseudomonas spp.	+15.08	14	–170.18	11
Serratia spp.	–117.00	28	–187.20	20
Gram-negative bacilli	–272.09	44	–154.51	55
Yeast	–243.50	38	–168.00	26
Arcanobacterium pyogenes	–348.15	112	–194.24	68
Corynebacterium bovis	–164.72	1431	–125.04	944
Gram-positive bacilli	–66.43	78	–139.51	41
Mycoplasma spp.	–451.63	25	–229.89	19
Group G streptococci	–207.88	14	–200.57	14
Pasteurella spp.	–500.12	14	–253.50	8
Proteus spp.	–190.85	82	–155.15	61
Mold	–13.13	67	–138.07	29
Nocardia spp.	+544.07	27	–52.00	1
Prototheca spp.	–249.22	27	–168.00	26
Fungus	–678.75	3	–104.00	1
Corynebacterium spp.	+351.79	35	–95.33	24
Enterobacter spp.	–649.24	2	–312.00	1
Citrobacter spp.	–323.19	5	–93.60	5

[1]Estimates of dollars lost per lactation from mastitis based on 305-d mature equivalent milk production (305ME). Milk was valued at $13.00/cwt.

[2]Estimates of dollars lost per lactation from mastitis based on the linear score of the SCC (LS). Milk was valued at $13.00/cwt.

these estimates if higher producing cows are more likely to contract mastitis than lower producing herdmates, causing an underestimation of the true total loss. Etiologic agents affected the estimated cost per case of mastitis. Dollar loss per case per lactation was highest for mastitis caused by *Pasteurella* spp. and *Mycoplasma* spp. (mean of both methods was approximately $350.00 in lost milk), followed by mastitis caused by *Strep. agalactiae* and *A. pyogenes*. Of the four streptococcal and staphylococcal mastitis pathogens, *Strep. agalactiae* (mean estimate, ≈ $280.00), *Staph. aureus* ($170.00), and *Streptococcus* spp. ($155.00) were relatively costly per case. Those three pathogens were of major overall financial significance because they infected over one-fourth of all cows. Some other mastitis agents, including Gram-negative bacilli, *Prototheca* spp., yeast, and Group G streptococci, were not commonly isolated but were associated with >$200.00 in milk loss per case.

Other studies that estimated economic losses because of lost milk production caused by subclinical mastitis have not specified losses by etiologic agents. Estimates are usually calculated as money lost per cow per year but not per case of mastitis. However, estimates of the prevalence of mastitis at 45% have sometimes been used (7); this estimate is comparable with the results of this study. Assuming 45% prevalence of mastitis, cost estimates of milk loss per case of subclinical mastitis have been $180.00 (2), $244.00 (18), $263.00 (9), and $320.00 (17). Results of the present study are in the same range and suggest that milk loss with some pathogens is greater than these estimates.

Of the major mastitis agents, IMI caused by *Strep. agalactiae* and *Mycoplasma* spp. were associated with the lowest 305ME at 8200 kg (18,000 lb) and 8000 kg (17,500 lb), respectively. This result agrees with previous reports regarding *Strep. agalactiae* (8). *Streptococcus agalactiae* has also been found to be associated with herds with less progressive overall management practices (1), which may also contribute to its association with lower milk production.

Staphylococcus spp. were the single most common mastitis agents, which has been found in several previous studies (16, 24) and has been true in New York for many years (26). Overall prevalence of

TABLE 4. 305-Day mature equivalent milk production (305ME) for cows infected with mastitis pathogens.

Culture result	305ME		
	(kg)	(lb)	(no. of cows)
All cows	9405	20,690	29,504
Culture-positive	9132	20,090	10,598
Culture-negative	9578	21,071	18,906
Streptococcus agalactiae	8220	18,085	1345
Streptococcus spp.	9075	19,966	1763
Staphylococcus aureus	8929	19,644	2286
Staphylococcus spp.	9619	21,162	2996
Escherichia coli	9125	20,074	113
Klebsiella spp.	9647	21,223	49
Psuedomonas spp.	9630	21,187	14
Serratia spp.	9169	20,171	28
Gram-negative bacilli	8626	18,978	44
Yeast	8726	19,198	38
Arcanobacterium pyogenes	8360	18,393	112
Corynebacterium bovis	9002	19,804	1431
Gram-positive bacilli	9345	20,560	78
Mycoplasma spp.	7999	17,597	25
Group G streptococci	8851	19,472	14
Pasteurella spp.	7829	17,224	14
Proteus spp.	8910	19,603	82
Mold	9532	20,970	67
Nocardia spp.	11,480	25,256	27
Prototheca spp.	8706	19,154	27
Fungus	7205	15,850	3
Corynebacterium spp.	10,808	23,777	35
Enterobacter spp.	7308	16,077	2
Citrobacter spp.	8448	18,585	5

Staphylococcus spp. was approximately 10% among all cows, whether in DHIA herds or not. The financial impact of *Staphylococcus* spp. was lower (≈ $100.00) than the impact of other common infectious agents. Nevertheless, this pathogen can have major importance in some herds and should not be dismissed as being uniformly unimportant (26).

Prevalence of mastitis caused by *E. coli* and *Klebsiella* spp. on whole-herd surveys was quite low (0.6%). These pathogens are sometimes suspected by dairy producers and their advisors to be likely causes of increased mastitis and SCC in herds. The IMI caused by Gram-negative bacteria are of a relatively short duration and are not always detected by milk culture when present (23); therefore, the number of new IMI may be underestimated by whole-herd surveys at a given point in time. Nevertheless, any infectious agent that has a short duration of infection has, by definition, a true reduction in prevalence (prevalence = incidence × duration) compared with agents that usually persist longer in the mammary gland. Prevalence of IMI caused by coliform bacteria was 50 times less than that caused by staphylococci and streptococci in these dairy herds. Evidence (3, 10, 22) has been reported by others that environmental mastitis, particularly mastitis caused by *E. coli* and *Klebsiella* spp., has increased in relative importance, particularly in herds with a low SCC. Nevertheless, reported increases in the prevalence of coliform mastitis, particularly when entire dairy herds are tested, are often not statistically or economically significant (3, 10, 22). Results of this study suggest that Gram-negative bacteria remain a less common cause of IMI and mastitis costs than Gram-positive pathogens.

Mastitis caused by *Nocardia* spp., *Corynebacterium* spp., *Klebsiella* spp., *Pseudomonas* spp., and *Staphylococcus* spp. was associated with relatively high 305ME [>9545 kg (21,000 lb)]. Possibly higher producing cows are more likely to contract these cases and avoid major losses in milk production. Alternatively, those cows that do have major production losses may be culled quickly and fail to survive for sampling in whole-herd surveys.

Mean DIM at the time of detection of most mastitis agents was similar (range, 160 to 200 d). These values from surveys of entire herds do not represent DIM at onset of the IMI but the mean DIM when cows were determined to be positive for IMI; these mean values were similar for all cows, whether IMI were detected or not. However, cases of mastitis that were caused by *Mycoplasma* spp. were detected at a mean of <120 DIM. Cows at or near peak lactation seemed to be at greater risk for mastitis caused by *Mycoplasma* spp., or else that type of IMI was more detectable in the milk of those cows.

Overall prevalence of bovine mastitis apparently has decreased over the past 25 to 50 yr, but the disease is still common. Reductions of IMI caused by *Strep. agalactiae* and *Staph. aureus* have been accomplished. Despite the trend toward increased problems with Gram-negative mastitis of some dairy herds, streptococcal and staphylococcal mastitis remain the most common IMI, causing the greatest overall costs to dairy herds. Production and financial loss per case may be higher for some mastitis pathogens than previous estimates. Enrollment in a dairy herd testing program, such as DHIA, was associated with reduced mastitis in herds in New York and Pennsylvania.

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