Evaluation of 9 Treatments, Including No Treatment, for Efficacy Against 21 Different Bovine Mastitis Pathogens

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Abstract

Milk culture results from approximately 540,000 cows housed in approximately 3,500 dairy herds located in New York and northern Pennsylvania were retrospectively reviewed. 9563 cases included in analysis were cultured in consecutive months, had permanent cow identification, records of clinical mastitis signs (if present), records of whether mastitis was treated with an antibiotic, unknown or antibiotic combination, or no treatment at all. Overall bacteriological cure rate was 68.0% (6503/9563); subclinical cases, 67.9% cure rate (6311/9290), did not differ from clinical cases, 70.3% cure rate (192/273). Treated cases had a higher cure rate (75.3%) than untreated cases (64.8%). Antibiotic treatments that significantly differed from the overall cure rate of 68.0% were: amoxicillin 82.4%; unknown/combined treatments 76.3%; erythromycin 76.2%; cloxacillin 73.6%; pirlimycin 43.8%. Cephapirin, hetacillin, and penicillin did not differ from the mean cure rate or from the untreated cure rate. Agents for which some antibiotics were associated with increased cure rates, compared with no treatment, included *Streptococcus agalactiae*, streptococci other than *Strep ag*, and *Corynebacterium bovis*. The antibiotic most commonly associated with higher cure rates was amoxicillin. Most mastitis agents showed no difference in bacteriologic cure rates in association with any treatment, including no treatment.

Introduction

Most financial loss from treatment of bovine mastitis is a result of milk discarded. The question of differences in outcome among different types of treatments used on bovine mastitis is economically important, and has received increased attention in recent years.[1-3] This retrospective study compares bacteriologic cure rates associated with different mastitis treatments, including no treatment at all.

Materials and Methods

Dairy herds studied were located in New York and northern Pennsylvania. Milk culture results from approximately 540,000 milk samples from cows housed in approximately 3,500 dairy herds visited by the Eastern and Central Laboratories (located in Cobleskill and Ithaca, NY, respectively) of the Quality Milk Promotion Services at Cornell University from 1985 to 1996 were retrospectively reviewed.

The following criteria were needed for inclusion in this analysis: 1. Clinical mastitis signs (if present) were recorded and the affected quarter(s) noted. 2. Milk was recultured within the next month. 3. Treatment with an antibiotic, unknown or antibiotic combination, or no treatment at all was administered following the first culture sample, and before the second culture sample was collected. 4. Treatments were properly recorded and cows were definitively identified as the same animals.

Unknown or combination therapy resulted when dairy producers routinely chose from among two or more different antibiotics or combination products for mastitis therapy, and did not know for certain what the antibiotics in the treatment mixture were, or could not specify at the time of the second farm visit which treatment had been used. Nevertheless, if records of treatment and milk withholding clearly identified that a cow had been treated, her case was included as having been treated with unknown or combination therapy.

Bacterial isolation of pathogens was the only test used to assess bacteriologic cures. Microbiology methods were as recommended by the National Mastitis

Council, and have been described earlier.[4] All cases meeting the above criteria were judged as a failure of therapy when the same mastitis pathogen was isolated from the second sample as from the first sample, or as a cure when the pathogen was not isolated from the second sample. No attempt to assess clinical cure based on relief of signs was made. Differences in bacterial cure rates among treatments were tested using Chi-square.

Results

There were 21 mastitis pathogens evaluated, and 8 antibiotic treatments including unknown/combined treatments, as well as those cases with no treatment of any kind. There were 9563 mastitis cases meeting the criteria, 9290 subclinical cases and 273 clinical cases.

For all cases of mastitis, bacteriological cure rate was 68.0% (6503/9563); subclinical cases, 67.9% (6311/9290), did not differ from clinical cases, 70.3% (192/273) (Table 1). Treated cases had a higher cure rate of 75.3% (2213/2940), than untreated cases, 64.8% (4290/6623), $P < .001$. Antibiotic treatments that significantly differed from the overall cure rate of 68.0% were: amoxicillin 82.4% (937/1137), $P < .001$; unknown/combined treatments 76.3% (222/291), $P < .001$; erythromycin 76.2% (109/143), $P < .05$; cloxacillin 73.6% (484/658), $P < .01$; pirlimycin 43.8% (32/73), $P < .001$. Cephapirin, hetacillin, and penicillin did not differ from the mean cure rate or from the untreated cure rate (Table 1).

Table 1. Bacteriologic Cure Rates for 21 Mastitis Agents

Treatment	All Cases Cure Rate	Subclinical Cure Rate	Clinical Cure Rate
All Cases	6503/9563(68.0%)	6311/9290(67.9%)	192/273(70.3%)
Untreated	4290/6623(64.8%)	4206/6481(64.9%)	84/142(59.2%)
Treated	2213/2940(75.3%)***	2105/2809(74.9%)	108/131(82.4%)
Amoxicillin	937/1137(82.4%)***	908/1103(82.3%)	29/34(85.3%)
Cephapirin	169/242(69.8%)	152/222(68.5%)	17/20(85.0%)
Cloxacillin	484/658(73.6%)**	463/632(73.3%)	21/26(80.8%)
Erthromycin	109/143(76.2%)*	106/139(76.3%)	3/4(75.0%)
Hetacillin	36/59(61.0%)	35/56(62.5%)	1/3(33.3%)
Penicillin	224/337(66.5%)	195/301(64.8%)	29/36(80.6%)
Pirlimycin	32/73(43.8%)***	32/73(43.8%)	N/A
Unknown/Mixed	222/291(76.3%)***	214/283(75.6%)	8/8(100%)

*p<.05, chi-square test. **p<.01, chi-square test.***p<.001, chi-square test.

For *Streptococcus agalactiae*, treated cases had a cure rate of 77.1% (1726/2238), compared with 26.5% (31/117) for untreated cases, $P < .001$ (Table 2). The *Strep ag* clinical cure rate of 85.6% (89/104) was significantly higher than the subclinical cure rate of 74.1% (1668/2251), $P < .05$. Antibiotic treatments that significantly differed from the overall cure rate of 74.6% were: amoxicillin 85.7% (732/854), $P < .001$; cephapirin 67.2% (129/192), $P < .05$; penicillin 65.1% (162/249), $P < .001$; hetacillin 61.7% (29/47), $P < .05$; pirlimycin 43.8% (32/73), $P < .001$. Cloxacillin, erythromycin, and unknown/combined treatments did not differ from the mean cure rate (Table 2).

Table 2. *Strep agalactiae*

Treatment	All Cases Cure Rate	Subclinical Cure Rate	Clinical Cure Rate
All Cases	1757/2355(74.6%)	1668/2251(74.1%)	89/104(85.6%)*
Untreated	31/117(26.5%)	31/116(26.7%)	0/1(0%)
Treated	1726/2238(77.1%)***	1637/2135(76.7%)	89/103(86.4%)*
Amoxicillin	732/854(85.7%)***	709/829(85.5%)	23/25(92.0%)
Cephapirin	129/192(67.2%)*	115/175(65.7%)	14/17(82.4%)
Cloxacillin	393/508(77.4%)	376/487(77.2%)	17/21(81.0%)
Erythromycin	81/99(81.8%)	78/96(81.3%)	3/3(100%)
Hetacillin	29/47(61.7%)*	28/45(62.2%)	1/2(50.0%)
Penicillin	162/249(65.1%)***	139/222(62.6%)	23/27(85.2%)*
Pirlimycin	32/73(43.8%)***	32/73(43.8%)	NA
Unknown/Mixed	168/216(77.8%)	160/208(76.9%)	8/8(100%)

*p<.05, chi-square test. **p<.01 , chi-square test. ***p<.001, chi-square test.

For *Staphylococcus aureus* (1356 cases), cure rates for all cases, treated cases and untreated cases were 43.8%, 47.8%, and 42.9%, respectively, not different; treatment used also did not affect cure rate (Table 3).

Table 3. *Staph aureus*

Treatment	All Cases Cure Rate	Subclinical Cure Rate	Clinical Cure Rate
All Cases	594/1356(43.8%)	573/1299(44.1%)	21/57(36.8%)
Untreated	485/1130(42.9%)	472/1088(43.4%)	13/42(31%)
Treated	109/226(47.8%)	101/211(47.9%)	8/15(53.3%)
Amoxicillin	32/74(43.2%)	30/70(42.9%)	2/4(50.0%)
Cephapirin	8/16(50.0%)	6/14(42.9%)	2/2(100%)
Cloxacillin	24/50(48%)	23/49(46.9%)	1/1(100%)
Erythromycin	15/24(62.5%)	15/23(65.2%)	0/1(0%)
Hetacillin	1/6(16.7%)	1/5(20.0%)	0/1(0%)
Penicillin	18/29(62.1%)	15/23(65.2%)	3/6(50.0%)
Pirlimycin	NA	NA	NA
Unknown/Mixed	11/27(40.7%)	11/27(40.7%)	NA

For streptococci other than *Strep ag*, (*Strep* sp), treated cases had cure rate 83.0% (78/94), higher than 66.0% (735/1114) for untreated cases, $P < .001$. The only antibiotic that differed from the overall cure rate for *Strep* sp cases was amoxicillin, 90.9% (40/44), $P < .001$ (Table 4).

Table 4. *Strep* sp. (non-agalactiae)

Treatment	All Cases Cure Rate	Subclinical Cure Rate	Clinical Cure Rate
All Cases	813/1208(67.3%)	779/1157(67.3%)	34/51(66.7%)
Untreated	735/1114(66.0%)	707/1070(66.0%)	28/44(63.6%)
Treated	78/94(83.0%)***	72/87(82.8%)	6/7(85.7%)
Amoxicillin	40/44(90.9%)***	36/40(90.0%)	4/4(100%)
Cephapirin	3/3(100%)	3/3(100%)	NA
Cloxacillin	11/15(73.3%)	11/14(78.6%)	0/1(0%)
Erythromycin	4/8(50.0%)	4/8(50.0%)	NA
Hetacillin	2/2(100%)	2/2(100%)	NA
Penicillin	11/13(84.6%)	9/11(81.8%)	2/2(100%)
Pirlimycin	NA	NA	NA
Unknown/Mixed	7/9(77.8%)	7/9(77.8%)	NA

*** p<.001, chi-square test.

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For Staphylococci other than *Staph aureus*, (*Staph* sp), treated cases had cure rate 83.5% (142/170), higher than 72.2% (1461/2023) for untreated cases, P < .001. The antibiotic treatments that differed from the overall cure rate for *Staph* sp cases were unknown/combined treatments 96.6% (28/29), P < .01, and amoxicillin 87.3% (48/55), P < .05 (Table 5).

Table 5. *Staph* species (coagulase-neg.)

	All Cases	Subclinical	Clinical
Treatment	Cure Rate	Cure Rate	Cure Rate
All Cases	1603/2193(73.1%)	1590/2179(73.0%)	13/14(92.9%)
Untreated	1461/2023(72.2%)	1450/2011(72.1%)	11/12(91.7%)
Treated	142/170(83.5%)***	140/168(83.3%)	2/2(100%)
Amoxicillin	48/55(87.3%)*	48/55(87.3%)	NA
Cephapirin	17/19(89.5%)	16/18(88.9%)	1/1(100%)
Cloxacillin	26/34(76.5%)	25/33(75.8%)	1/1(100%)
Erythromycin	6/8(75.0%)	6/8(75.0%)	NA
Hetacillin	NA	NA	NA
Penicillin	17/25(68.0%)	17/25(68.0%)	NA
Pirlimycin	NA	NA	NA
Unknown/Mixed	28/29(96.6%)**	28/29(96.6%)	NA

*p<.05, chi-square test. **p<.01, chi-square test. ***p<.001, chi-square test

Antibiotics associated with higher than overall cure rates for *C. bovis* were amoxicillin 76.5%, and cephapirin 100%, both P < .05. *Arcanobacterium pyogenes* clinical cases had 64.3% (9/14) cure rate, lower than 86.7% (60/69) for subclinical cases, P < .05. However, choice of therapy was not associated with differences in cure rates.

All 4 treated cases of *Prototheca* sp. cured, significantly higher than 53.8% (14/26) for untreated cases. However, due to small numbers of observations, no particular antibiotic was detected as having an increased cure rate.

Cure rates for mastitis cases caused by *E. coli*, *Klebsiella* sp., *Enterobacter* sp., *Citrobacter* sp., *Pseudomonas* sp., *Pasteurella* sp., *Proteus* sp., *Serratia* sp., gram-positive and gram-negative bacilli, yeast, mold, *Nocardia* sp., *Corynebacterium* sp., and Group G streptococci were not associated with antibiotic therapy.

Discussion

These results are not from a prospective planned experiment. Some producers may have had more chronic well-established cases in their herds than others, or other treatment problems. The authors attempted to exclude all cases with any doubts about validity of treatment from this analysis. This evaluation of cure rates is best suited to *differences among treatments* because only one pre-treatment and only one post-treatment culture overestimates cure rates.[5]

The results suggest that the difference between spontaneous and antibiotic associated cure rates is large for *Strep ag* mastitis, but not as great for other types of mastitis. The antibiotic most consistently associated with increased cure rates for different agents was amoxicillin. Bacteriologic cure rates for untreated coliform mastitis cases were high.

Table 6. *E. coli*

	All Cases	Subclinical	Clinical
Treatment	Cure Rate	Cure Rate	Cure Rate
All Cases	88/100(88%)	79/91(86.8%)	9/9(100%)
Untreated	83/95(87.4%)	75/87(86.2%)	8/8(100%)
Treated	5/5(100%)	4/4(100%)	1/1(100%)
Amoxicillin	NA	NA	NA
Cephapirin	1/1(100%)	1/1(100%)	NA
Cloxacillin	1/1(100%)	NA	1/1(100%)
Erythromycin	1/1(100%)	1/1(100%))	NA
Hetacillin	1/1(100%)	1/1(100%)	NA
Penicillin	1/1(100%)	1/1(100%)	NA
Pirlimycin	NA	NA	NA
Unknown/Mixed	NA	NA	NA

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