Antibiogram Patterns for Isolates From Bovine Mastitis Over 15 Years

Garrison LL, Schukken YH, Gonzalez RN, Hilton B

Quality Milk Promotion Services, Cornell University, Ithaca, NY, USA 14850

Bovine mastitis is an economically important disease resulting in annual losses to the U.S. dairy industry of approximately 2 billion dollars. These losses are from reduced production, discarded milk, culling, and pharmaceuticals[8]. It has been determined that in New York state, major pathogens are Streptococcus agalactiae, Staphylococcus aureus, Streptococcus spp., Staphylococcus spp., and Mycoplasma[10].

Seventeen million pounds of antibiotics are used in animals each year in the United States[1]. Approximately 90% of the antibiotics used in agriculture are given as growth-promotants and prophylactic agents (e.g. dry cow therapy)[5]. Many of the antibiotics used on farms are given by farm workers that may not be familiar with principles of antibiotic therapy and may not adhere to recommended therapeutic regimens. Antibiotic use promoting the development of microbial resistance is an issue of growing concern in both the human and veterinary medical arenas.

Quality Milk Promotion Services has been available to the dairy industry of New York for the last 50 years. Data on culture results from milk samples and the susceptibility patterns of isolates are available on paper records for approximately the last 15 years. This data, from more than 3,400 samples, has been transferred to an electronic database for graphical and statistical analyses.

Materials and Methods

This is an observational historical study of susceptibility tests performed on 1180 Streptococcus spp. and 406 Staphylococcus aureus isolated from milk samples. No species determinations were available for environmental Streptococci, but we assume they are predominantly Strep uberis and Strep dysgalactiae. Isolates were submitted by veterinarians and dairy producers throughout New York. The majority of the isolates submitted are from cows in herds that are experiencing an outbreak of clinical mastitis or from cows with non-responsive intramammary infections.

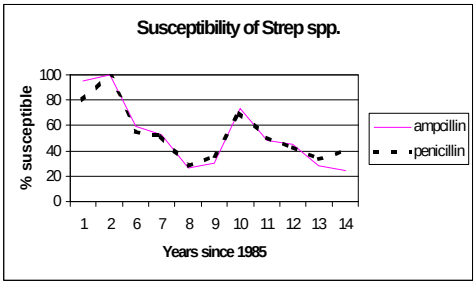
Determination of antibiotic susceptibility or resistance was determined by the agar disk diffusion method on Mueller-Hinton agar with 5% calf serum and results were interpreted according to NCCLS standards[7]. Coding was in three categories: susceptible, intermediate, and resistant. For statistical analysis, two categories were used susceptible and intermediate/resistant.

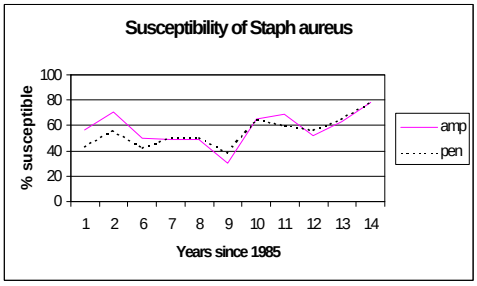
Statistical analysis was done using chi-square and logistic regression analyses. Logistic regression was used to evaluate linear trends in time. Significance of

changes in susceptibility over time for Streptococcus and Staphylococcus spp. was evaluated at $p \leq 0.05$.

Results

Penicillins and cephalosporins are β– lactam antibiotics that are widely used in both lactating and dry cow mastitis therapies. Analysis of these data indicates significant decreases in susceptibility of Streptococcus spp. to ampicillin, cloxacillin, and penicillin. Susceptibility of Strep spp. to both amoxicillin and cephalothin remained stable. Overall percent susceptible were 89% and 98%, respectively.





There were also changes in antibiogram patterns to other routinely used antimicrobials. Strep spp. showed declining susceptibility to erythromycin, pirlimycin, and tetracycline. Erythromycin and pirlimycin are available as lactating cow preparations; tetracyline is used as an intravenous antibiotic and may also (but rarely and off-label) be used as an intramammary infusion for dry cows.

Conversely, Staph aureus showed significant increases in susceptibility to both ampicillin and penicillin. Susceptibility to amoxicillin (94%) and cephalothin (98%) remained stable. Susceptibility to cloxacillin appeared to decrease but the trend was not significant. Staph aureus susceptibility to erythromycin, pirlimycin, and tetracycline did not change significantly over time.

Discussion

Results of a previous study conducted from 1975 to 1979 at Quality Milk Promotion Services indicated yearly fluctuations in susceptibility but saw no significant linear change over the 5 year period[4]. Another study conducted over 4 years in the United Kingdom echoed these results, finding year to year fluctuations but no significant trend over time[6]. However, results of this analysis show distinct changes over time in antibiotic susceptibility for the two of the most common groups of mastitis pathogens. This is likely related to the longer time period over which our observations were made.

The contrast between the 1975 and 1999 data, a 25 year span, is striking. Davidson found that Streptococcus spp. were 95% susceptible to ampicillin in 1975; our data indicates a 26% susceptibility for Streptococcus spp. in 1999. Staph aureus was 49% susceptible in 1975 to ampicillin; in 1999, the overall susceptibility to ampicillin was 79%. This may reflect changes in mastitis treatments used over the years.

New Zealand researchers looked at 25,000 antibiotic susceptibility tests over 20 years. Similar to this study, these researchers found a small increase in the number of Staph aureus isolates susceptible to penicillin. In contrast, they found no evidence of resistance of Staph aureus or Strep spp. to tetracycline, cloxacillin, or cephalothin[3].

The apparent decline in susceptibility of Streptococcus spp. to commonly used antibiotics is alarming, however further investigation of these patterns is warranted. Species differences in susceptibility were not taken into account. Strep uberis has been found to be less susceptible to inhibition by erythromycin, tetracycline, and streptomycin than Streptococcus dysgalactiae[2].

Also, although these samples were submitted by many veterinarians from many cows located throughout New York State, the population may be skewed since they represent mostly clinical mastitis samples. Since subclinical mastitis often goes undetected, cultures and antibiograms are not performed.

These findings show that developing microbial resistance to antibiotics is of concern and warrants careful monitoring. It would be useful to follow changes in susceptibility over time within both individual cows, within herds, and within geographical regions. Identifying strain differences with regard to pathogenicity, mechanisms of antibiotic resistance in individual strains, and how this resistance transfers is important and an area for further study.

References

1. Animal Health Institute. *Survey on Antibiotic Use in Humans and Animals in* 1998. Feb. 2000
2. Brown, M.B. and A.E. Scasserra. *Antimicrobial Resistance in Streptococcal Species Isolated from Bovine Mammary Glands.* Am. J. Vet. Res. 1990. 51:12 (2015-18).
3. Carman, M. and E. Gardner. *Trends in Bovine Mastitis and Sensitivity Patterns 1976-1995.* Ministry of Agriculture and Forestry-New Zealand 1998.
4. Davidson, J.N. *Antibiotic Resistance Patterns of Bovine Mastitis Pathogens.* Proc. 19th National Mastitis Council mtg. 1980. (181-185).
5. Khachatourians, G.G. *Agricultural Use of Antibiotics and the Evolution and Transfer of Antibiotic Resistant Bacteria.* CMAJ. 1998. 159 (1130).
6. Mackie, D.P., E.F. Logan, D.A. Pollock, and S.P. Rodgers. *Antibiotic Sensitivity of Bovine Staphylococcal and Coliform Mastitis Isolates Over 4 Years.* Vet. Rec. 1998. 123:20 (515-17).
7. NCCLS *Performance Standards of Antimicrobial Disk Susceptibility Tests.* 6th edition. Vol. 17. Jan. 1997.
8. National Mastitis Council. *Current Concepts in Bovine Mastitis.* 3rd edition (p.7). 1987.
9. Report of a WHO meeting on the Medical Impact of the Use of Antimicrobials in Food Animals-Berlin. October 1997.
10. Wilson, D.J., R.N. Gonzalez, and H.H. Das. *Bovine Mastitis Pathogens in New York and Pennsylvania: Prevalence and Effects on Somatic Cell Count and Milk Production.* J. Dairy Sci. 80:10 (2592-2598). 1997.