Antibacterial Fluoroquinolones as a Treatment for Mycoplasma Conjunctivitis in House Finches

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Introduction

Since the outbreak of mycoplasma conjunctivitis among house finches in 1994, the eastern house finch population has been cut in half (Clark 2013). In 1994, citizen scientists in the Washington D.C. area involved in Project Feederwatch with the Cornell Lab of Ornithology noticed that many house finches (*Carpodacus mexicanus*) had red, swollen eyes when visiting their feeders (Dhondt et al., 1998). This disease caused by the bacterium *Mycoplasma gallisepticum,* has been nicknamed “House Finch Eye Disease.” Since then, the disease has spread all over the United States: north into Canada, south to Florida, and across the Rockies into the west coast. Outbreaks of the disease are typically seasonal, with increased prevalence in the spring and a drop in autumn (Hosseini et al., 2006). Studies show that many of the infected birds cannot survive due to blindness and difficulty finding food, especially in the winter when food is difficult to find. Finches with mycoplasma conjunctivitis also experience difficulty breathing and other respiratory symptoms. The disease passes from bird to bird through close proximity and bodily contact, creating a higher rate of occurrence in flocks. Other species have the ability to carry the disease, but most do not struggle with the physical symptoms faced by house finches. Due to the visitation of house finches to bird feeders, the close proximity of many birds in a flock leads to the spread of the disease (Adelman et al., 2013).

To determine which medicine is most effective against *M. gallisepticum*, systematic literature review was used to analyse peer-reviewed studies focussing on Polymerase Chain Reactions (PCR). This test (PCR) can be used to detect *M. gallisepticum* in house finches before and after medication is applied, and most studies on house finch eye disease use this test. Therefore, comparing PCR readings from different studies showed which medicine is most effective. The process of PCR analysis involves the amplification of DNA and the creation of millions of exact DNA replications. The DNA polymerase enzyme uses existing DNA as a template to generate new DNA strands. Then, a chain reaction makes enough DNA until the DNA is visible to the naked eye (Edwards et al., 1991). Papers referenced in this study used PCR to amplify DNA from eye swabs of house finches that have been infected with *M. gallispeticum.*

House finches play an important role in their ecosystems. They eat primarily seeds and some fruits, which limits the growth of wild plant species (Beal, 1907). Cooper’s and sharp-shinned hawks prey on house finches, while other bird species, rodents, and snakes eat the eggs of house finches (Cannings et al., 1987). A decline in house finches could hurt theses predators as well. Clearly, finding a cure to house finch eye disease proves an important task, for many groups would be affected by their extinction.The purpose of the present study was to compare the known medications and prove one as the best option for implementation to combat mycoplasma conjunctivitis.

Hypothesis

Fluoroquinolones will prove more effective than macrolides in the eradication of mycoplasma conjunctivitis.

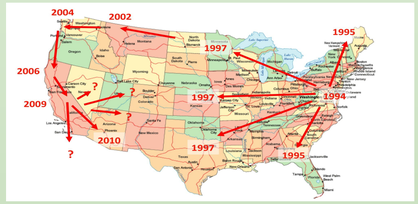


Figure 1: Spread of mycoplasma conjunctivitis (projectfeederwatch.org)

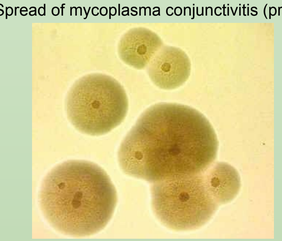
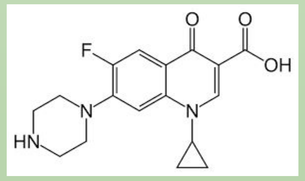


Figure 2: *Mycoplasma gallispticum* bacteria (Roberts et al., 2001).



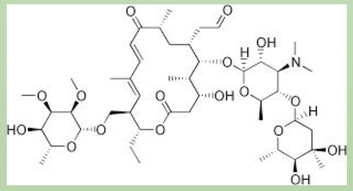


Figure 3: **Left-** Ciprofloxacin, a fluoroquinolone (Hooper, 2001) **Right-** Tylosin, a macrolide (Siegrist et al., 1981)

Methods

Peer-reviewed scholarly articles retrieved from the internet acted as the main source of data. Peer-reviewed articles related to house finch eye disease were retrieved by searching in online databases such as Ebscohost, Google Scholar, Elsevier, BioOne, JSTOR, and PLOS, among others. Specifically, studies that used PCR (Polymerase Chain Reaction) analysis were used to measure the effectiveness of various medicines in lowering the quantity of *Mycoplasma gallisepticum* bacteria from the body of house finches. Since PCR is used in most studies involving mycoplasma conjunctivitis, PCR readings from different papers were used in order to draw conclusions on which medicines were most effective, even though data came from different studies. The time frame of the articles used for data ranged from when the disease was first discovered in 1994 until 2017.

In the papers used for data, PCR analysis was effective in amplifying DNA from the *M. gallisepticum* bacterium. If *M. gallisepticum* DNA was amplified and detected in PCR analysis, then the house finch was determined to be infected by the bacterium. The numbers of birds infected by *M. gallisepticum* before and after treatment were extracted from papers for data. If a bird was not positive of *M. gallisepticum* by PCR after treatment, then it was determined that the bird was cured. When extracting data, the total number of birds infected at the beginning of treatment and the total of birds still infected after the treatment was completed in each study were recorded. If a study did multiple trials of the same treatment, then all trials were recorded. All data used came from experiments that used either antibacterial macrolides or antibacterial fluoroquinolones to treat mycoplasma conjunctivitis in house finches.

Results

Data was found on both macrolide and fluoroquinolone antibiotics that were used against the *M. gallisepticum* bacterium. Macrolide drugs included primarily tylosin, along with tiamulin and tylvalosin. Fluoroquinolone drugs used included enrofloxacin, danofloxacin, and ciprofloxacin. Data was collected from 8 groups treated with macrolides and 8 groups treated with fluoroquinolones. The number of birds positive by PCR before each treatment and then after each treatment were recorded (Table 1). The number of birds positive of *Mycoplasma gallisepticum* decreased significantly when treated with macrolides ($p = 2.33E-06$), as well as when treated with fluoroquinolones ($p= 5.87E-05$).

Table 1. Persistence of Mycoplasma gallisepticum in PCR detection through two antibiotic treatment types.

Antibiotic Type	Birds Positive by PCR Before Treatment	Birds Positive by PCR After Treatment	Data Source
Antibacterial Macrolides	45	14	Tanner et. al
	45	18	Tanner et. al
	50	20	Jordan et. al.
	50	16	Jordan et. al.
	45	25	Migaki et. al
	45	14	Migaki et. al
	45	1	Migaki et. al
	36	9	Forrester et. al
Antibacterial Fluoroquinolones	45	0	Tanner et. al
	45	5	Tanner et. al
	12	4	Wellehan et. al
	50	14	Jordan et. al
	45	1	Migaki et. al
	45	0	Migaki et. al
	45	0	Migaki et. al
	25	0	Stanley et. al

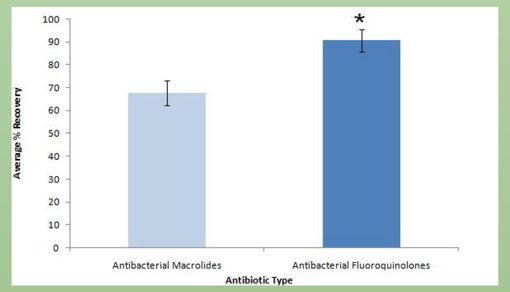


Figure 4: This Figure shows the average percent recovery of house finches treated with two different types of antibiotics with standard error bars.

a.

b.

Figure 5: *a.* Healthy *Carpodacus mexicanus* (House finch) next to *b.* A bird infected with *Mycoplasma gallisepticum* (Hartup et al., 1998).

Discussion

Data shows that the most effective treatments for mycoplasma conjunctivitis are antibacterial fluoroquinolones. These treatments are effective in eradicating the *Mycoplasma gallisepticum* bacteria from the house finch body completely, as shown by PCR analysis. The recovery rates of birds treated with fluoroquinolones was significantly higher than those treated macrolides. Therefore, it is clear that medications such as enrofloxacin, danofloxacin, ciprofloxacin, and other fluoroquinolones should be implemented to treat mycoplasma conjunctivitis to preserve the house finch species and slow mortality rates. Since antibacterial fluoroquinolones proved more effective than antibacterial macrolides in eliminating conjunctivitis, these medicines should be implemented to cure house finch populations.

The main difference between the two antibiotic groups is their mechanisms of action. Fluoroquinolones fight bacteria by inhibiting the actions of the topoisomerase, an enzyme that overwinds or unwinds DNA strands. The topoisomerase allows for the DNA polymerase to effectively copy and replicate DNA, which is necessary for the reproduction of bacteria (Hooper, 2001). Since fluoroquinolones inhibit the reproduction of bacteria, they are effective in destroying bacteria populations, including populations of *M. gallisepticum*. Macrolides on the other hand fight bacteria by inhibiting the function of the peptidyl transferase, and enzyme that generates peptide bonds between amino acids to form proteins. Since macrolides prevent the formation of new proteins, they inhibit bacterial reproduction (Siegrist et al., 1981). Fluoroquinolones are more effective in eradicating *M. gallisepticum* than macrolides, so it may be possible that inhibiting the topoisomerase is more important than limiting the peptidyl transferase in fighting the *M. gallisepticum* bacteria.

Conclusion

Fluoroquinolones were significantly more effective than macrolides in the antibiotic treatment of mycoplasma conjunctivitis. PCR analysis showed that house finches recover from mycoplasma conjunctivitis at a higher rate with fluoroquinolones than macrolides. Fluoroquinolones are a better treatment for house finch eye disease, and it should be implemented on a large scale.

Further Work/ Acknowledgements

Further work could be done to investigate which specific fluoroquinolones are best. Also more could be done to investigate methods of implementation of fluoroquinolones. I would like to thank my instructor, Dr. Nikki Malhotra, as well as my mentor Mr. Joel Baublits for guiding me throughout this project.

References

Beal, E. E. L. 1907. Birds of California in relation to the fruit industry, Pt. 1. Biol. Survey Bull. no. 30.

Cannings, R. A., R. J. Cannings and S. G. Cannings. 1987. Birds of the Okanagan Valley, British Columbia. Victoria: Royal British Columbia Museum.

Clark, P. (2013, February 12). House finch eye disease: an update. Retrieved December 17, 2017, from http://www.washingtonpost.com/wp-srv/special/metro/urban-jungle/pages/130212.html

Dhondt, A. A., Dhondt, K. V., & Mccleery, B. V. (2008). Comparative infectiousness of three passerine bird species after experimental inoculation with Mycoplasma gallisepticum. *Avian Pathology, 37*(6), 635-640. doi:10.1080/03079450802499100

Hooper, D. (2001). Emerging Mechanisms of Fluoroquinolone Resistance. *Emerging Infectious Diseases, 7*(2), 337-341. doi:10.3201/eid0702.010239

Mashima, T., Ley, D., Stoskopf, M., Miller, E., Welte, S., Berkhoff, J., . . . Fleming, W. (1997). Evaluation of Treatment of Conjunctivitis Associated with Mycoplasma gallisepticum in House Finches (Carpodacus mexicanus). *Journal of Avian Medicine and Surgery, 11*(1), 20-24.

See Paper for All References