Bacteria and Antibiotics Resistance

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Problem Statement

To identify why certain bacteria becomes resistant to antibiotics. Antibiotic resistance eliminates drug effectiveness designed to cure or prevent infections in humans and animals.

Bacterial resistance to antibiotics causes harm.

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Abstract

By identifying why bacteria survives and becomes resistant to certain drugs, we can prevent the spread of harmful infections to both humans and animals.

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Hypothesis

By using different types of antibiotics and checking the composition of each prescription, we can tell which one is the best treatment.

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Animal Used in Research

Species	Dog
Breed	Doberman Pinscher
Age	5 Years Old
Gender	Male/Neutered
Color	Black
Features	Cropped Ears/Tail
Height	26 Inches/2 Feet
Weight	75 lbs
Name	Shadow

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Research Problem

April 2020

Shadow was diagnosed suffering from Otitis Externa on his left ear.
Otitis externa is an inflammation of the outer ear canal of dogs and cats. It causes swelling, itchiness, redness and collection of pus. He's having trouble sleeping due to ongoing ear irritation. The veterinarian prescribed Cefpodoxime for 7 days. After 10 days, Shadow's ear infection was gone.

June 2020

Shadow's ear infection came back and this time, the swelling is much bigger, redness and itching more intense. The vet prescribed Zymox for 7 days. As usual after 10 days , Shadow's ear infection healed.

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April 2020

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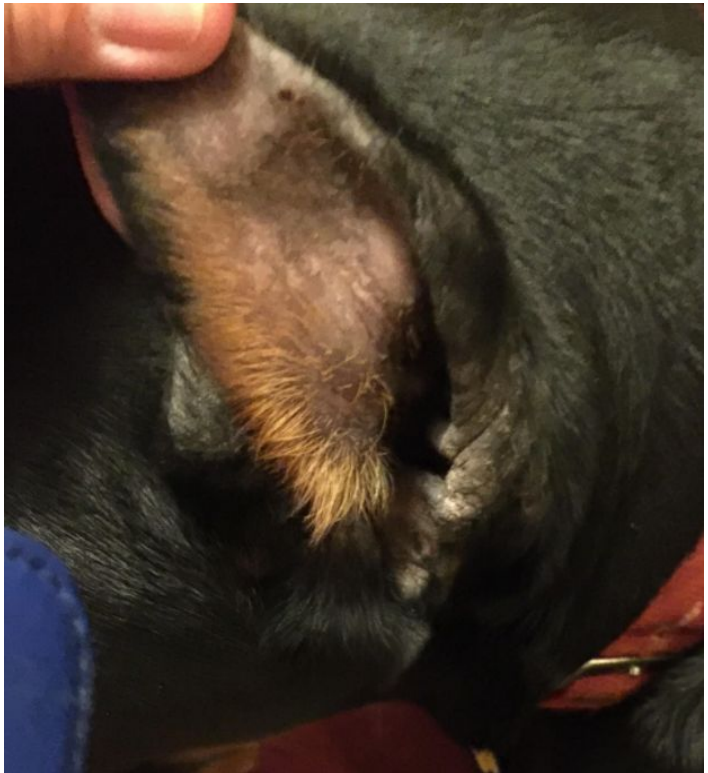
June 2020



August 2020

Shadow’s ongoing fight with ear infection. His left ear no longer erect.He kept on scratching the left affected ear.The skin was very red,swelling and painful to touch. The veterinarian prescribed Cefpodoxime and Hydrocortisone for 7 days. After a while, Shadow’s ear was healed again.

October 2020

Shadow’s ear infection came back with a vengeance. This time,his left ear swelling is much bigger.redder and itching so intense that he cried and whimpers whenever he scratched his left ear. He does not want it to be touch as it was so painful. Our experiment began to see if there are other alternatives to cure his ear infection.

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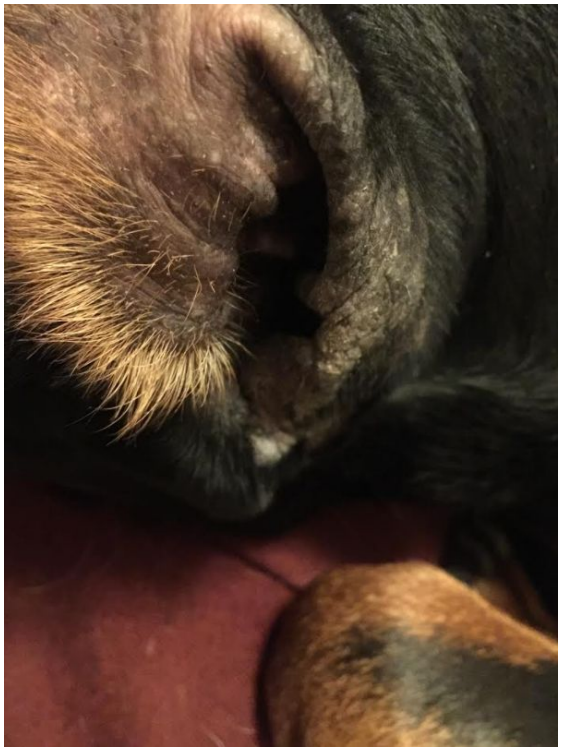
August 2020



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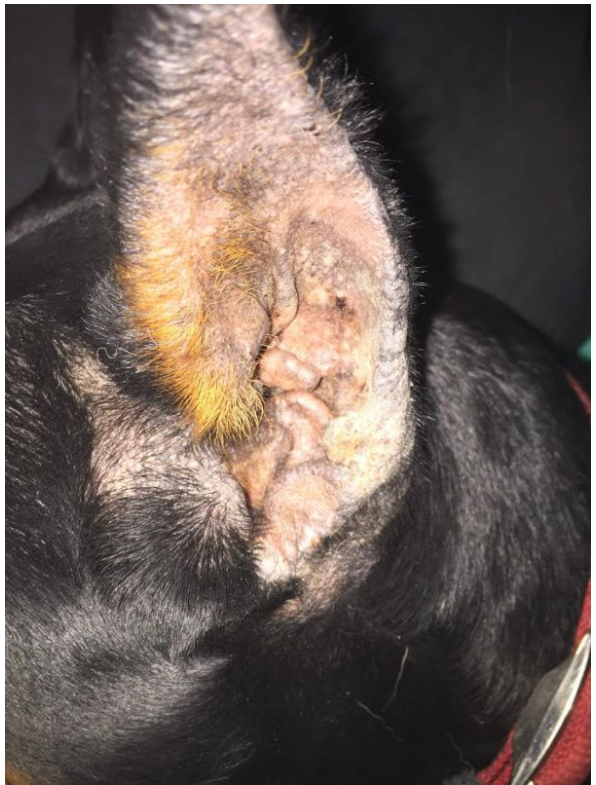
October 2020



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Observation

Shadow's on and off ear infection is a result of antibiotic resistant bacteria inside his ear canal. Staphylococcus aureus a bacterium capable of growth both anaerobic and aerobic.

Shadow's ear infection began in the spring due to water activities in the backyard. Combined with heat and humidity, his ear canal became a perfect breeding ground for bacterial growth.

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Methodology and Experimentation

Shadow's ear infection was caused by Staphylococcus aureus commonly found on the skin. Cefpodoxime and Zymox no longer worked to relieve his suffering.

October 2, 2020

Applied Clindamycin and Benzoyl Peroxide Gel to Shadow's affected left ear for 3 days. The result is promising. Swelling became smaller, less redness and less itching.

October 5, 2020

Applied Clindamycin and Benzoyl Peroxide Gel to Shadow's affected left ear for another 3 days.

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Results

October 8, 2020

Shadow's left ear looks much better. No more redness and swelling and itching. No longer painful to touch and he can now sleep without interruption. Applied Clindamycin and Benzoyl Peroxide Gel for another 3 days.

October 15, 2020

Shadow's left ear completely healed. No more redness, swelling, and itching. The disease made his ear permanently bent and left a little scar.

January 2021

Shadow's left ear has no more sign of infection.

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January 2021

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Medications Used

Cefpodoxime is prescription medication used to treat skin infection in dogs and cats.

Zymox is an ear solution commonly used to treat ear infections in dogs and cats.

Hydrocortisone Cream is an over the counter ointment to treat minor skin irritations in humans, dogs, and cats.

Clindamycin and Benzoyl Peroxide Gel is a prescription topical antibiotic to treat acne in humans.

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Analysis

The most common bacteria being treated by the above mentioned antibiotics is Streptococcus aureus most commonly found on the skin. **Cefpodoxime** and **Zymox** was not able to treat Shadow's ear infection because the bacteria become resistant.The skin remains moist throughout entire treatment and a perfect breeding ground for bacteria to survive. Hydrocortisone is not an antibiotic & was only prescribed by the veterinarian to relieve itchiness.

Clindamycin and Benzoyl Peroxide Gel was able to treat Shadow's ear infection because the bacteria is not resistant to human acne ointment. The ointment is effective in killing Propionibacterium for acne. The ointment also removes excess oil from skin, causing dryness and exfoliation of dead skin cells.

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Overall Results

Cefpodoxime and **Zymox** was prescribed to kill bacteria inside Shadow's ear canal to treat his Otitis externa. **Hydrocortisone**, is just to relieve itchiness. Both Cefpodoxime and Zymox failed to treat Shadow's ear infection as bacteria become resistant to antibiotics.No alteration of bacterial environment while using above named antibiotics.

Clindamycin and **Benzoyl Peroxide Gel** was able to cure Shadow's Otitis Externa on the left ear by removing excess oil, drying the skin, and exfoliating dead skin cells. The bacteria most likely thrives in moist skin to survive. By altering the conditions in their environment, the bacteria was not able to survive the new antibiotic applied on Shadow's left ear canal. The result is Shadow's overcoming the infection

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Antibiotics Used

CEFPODOXIME

A prescription medication most commonly used to treat skin infection in dogs. The drug only treats bacterial infections not viral infections in dogs.

Bacteria Susceptible to Cefpodoxime;

Staphylococcus and Pasteurella species
Streptococcus Canis
E. Coli

Dosage;

Can be a tablet or suspension and to be taken by mouth 2x a day up to 14 days. Tablet needs to be taken with food while suspension can be taken without food.

Continuation Cefpodoxime

Possible Side Effects

-Lack of Appetite
-Vomiting
-Diarrhea
-Drooling
-Fever 103° F (Contact Your Vet)

Precautions

Pregnant and lactating dogs cannot take Cefpodoxime
Dogs that are allergic cephalosporins or penicillines

ZYMOX

Ear solution for dogs with 0.50% hydrocortisone. The solution is highly effective to treat bacterial, fungal and yeast infections. The 0.50% hydrocortisone provides relief from itching, skin irritations, dermatitis, and minor inflammation.

Bacteria Susceptible to Zymox;

Staphylococcus species
Pseudomonas
Proteus
Malassezia

Dosage;

Put drops to uncleaned ear(s), filling ear canal and wipe to remove excess, apply once daily for 7 days

Continuation Zymox

Precautions

Do not use in dogs with suspected sensitivity to corticosteroids

Cannot be used in pregnant or lactating females

Avoid contact with eyes, nose, or other mucous membranes

For external use only

CLINDAMYCIN and BENZOYL PEROXIDE GEL

It is a topical antibiotic to treat acne. It will not cure acne but will keep it under control. The ointment works by killing Propionibacterium acnes. A tiny microbe that lives in the oily region of the skin pores. The ointment helps remove excess oil from skin and also removes dead skin cells. Clindamycin is useful in soft tissue infections caused by the following bacteria;

Bacteria Susceptible to Clindamycin and Benzoyl Peroxide Gel;

Staphylococcus Aureus
Streptococcus Pneumoniae
Streptococcus Pyogenes
Anaerobic Gram - Negative Bacteroides
Fusobacterium
Prevotella

Continuation Clindamycin and Benzoyl Peroxide Gel

Dosage

The ointment can be applied to the affected skin area. It is not taken my mouth. The ointment rarely causes allergic reactions.

Possible Side Effects

A bacterial resistance can develop fairly quickly

Addendum

Benzoyl Peroxide is effective for treating acne and does not induce antibiotic resistant. Application of Benzoyl Peroxide alone to the skin may result in redness, burning, and irritation. Combined with Clindamycin the mixture if a powerful acne treatment.

HYDROCORTISONE OINTMENT

A topical cream used to relieve itching and discomfort of various skin conditions. It reduces swelling, redness, and itching for skins conditions caused by eczema and psoriasis.

Bacteria Susceptible to Hydrocortisone Ointment;

Staphylococcus Aureus

Dosage

Apply the cream directly to skin for 3 to 7 days.

Possible Side Effects

Stinging, Burning, Irritation, Dryness, and Redness at the application site may occur

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Staphylococcus Infection

Also known as **Staphylococcus aureus** may cause skin infection due to production of bacterial toxins. May cause itchiness, redness, swelling, and collection of pus.

Some Staphylococcus aureus are methicillin-resistant or labeled as **MRSA**. Methicillin is a penicillin-related antibiotic that is once effective to fight staph infections. The emergence of **MRSA** strains rendered antibiotics useless and it was believed that the bacteria was able to mutate its genes to an uncoated protean capable of binding the drug preventing it from eradicating the bacteria completely. Today **MRSA** strains of Staphylococcus aureus causes infections to thousands of people worldwide.

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Staphylococcus aureus

Scanning electron micrograph of *S. aureus*; false color added

Scientific classification

Domain:	Bacteria
Phylum:	Firmicutes
Class:	Bacilli
Order:	Bacillales
Family:	Staphylococcaceae
Genus:	*Staphylococcus*
Species:	***S. aureus***

How Bacteria Becomes Resistant to Antibiotics

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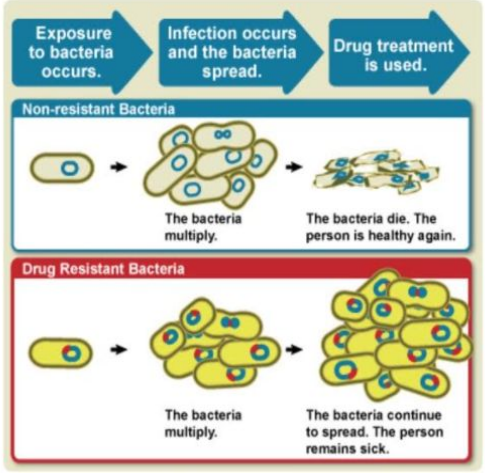
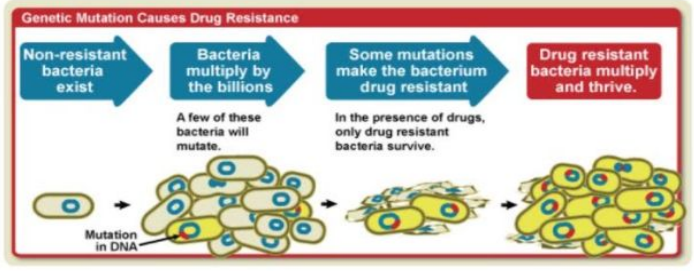
Selective Pressure

In the presence of an antimicrobial, microbes are either killed or, if they carry resistance genes, survive. These survivors will replicate, and their progeny will quickly become the dominant type throughout the microbial population.



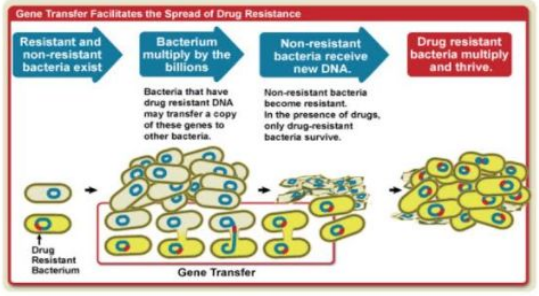
Mutation

Most microbes reproduce by dividing every few hours, allowing them to evolve rapidly and adapt quickly to new environmental conditions. During replication, mutations arise and some of these mutations may help an individual microbe survive exposure to an antimicrobial.



Gene Transfer

Microbes also may get genes from each other, including genes that make the microbe drug resistant. Bacteria multiply by the billions. Bacteria that have drug-resistant DNA may transfer a copy of these genes to other bacteria. Non-resistant bacteria receive the new DNA and become resistant to drugs. In the presence of drugs, only drug-resistant bacteria survive. The drug-resistant bacteria multiply and thrive.



Conclusion

The antibiotic resistance crisis is becoming a global problem. The cost of this crisis is overused and misused of antibiotics. There's no new antibiotics being developed worldwide to fight the crisis. The bacterial mutation that has antibiotic resistance is so fast that pharmaceutical companies cannot keep up. We need to research and do further testing and develop new antibiotics as fast as possible. Worldwide coordinated efforts and research are greatly needed to manage the crisis.

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Applications / Future Research

Staphylococcus aureus,the bacteria responsible for Shadow's ear infection is commonly found on skin and thrive in moist environment. Antibiotics Cefpodoxime and Zymox was not able to eradicate the infection because it kept Shadow's ear canal moist all the time enabling the bacteria to mutate and survive the medication.

Clindamycin and Benzoyl Peroxide gel dried up the skin inside Shadow's ear canal altering the bacteria's environment and survival defense and therefore was able to cure Shadow's ear infection.

While Clindamycin and Benzoyl Peroxide Gel successfully treated Shadow's ear infection,further research is needed to know if Shadow will remain vulnerable to ear infection throughout his life or develop immunity. We did not do clinical studies like swabbing his ear to determine other bacteria present.

Continuation Applications/Future Research

No microscopic experiment was done to determine why Clindamycin and Benzoyl Peroxide gel successfully altered the DNA bond of Staphylococcus aureus making it vulnerable.

No test was done to determine whether bacteria present in Shadow's ears are gram- positive, gram-negative,aerobic or anaerobic. These characteristics will fully confirms the existence of drug resistant bacteria and how antibiotics in the future can alter these genetic structures so permanent treatment on ear infections in cats and dogs will be possible in the future.

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