

A Review on Antibiotic Use in Livestock

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Abstract: Antibiotics are drugs to inhibit or kill growth of microorganisms in animal diseases. The farmers commonly use antibiotics in livestock for prevention of animal disease and growth promotion. Usage of antibiotics in livestock can leave antibiotic residues in meats and food-animal products. The most important adverse effect of antibiotic residues is the transfer of antibiotic resistant bacteria to the humans due to the mobile properties of resistance. Besides, it can contaminate the environment too. It has been obviously found that the problem of drug resistance arises from many factors related to humans, animals, and the environment. This review focused on antibiotic use in livestock.

Keywords: Antibiotic resistance, livestock, food, health, bacteria.

1. INTRODUCTION

The term antibiotics literally means “against life”; in this case, against microbes(1). In 1928, Sir Alexander Fleming investigated staphylococcus. Before he left for vacation, he forgot to place the petri dishes containing staphylococcus culture into an incubator. When he was back to his lab, Fleming noted that a mold called *Penicillium notatum* had contaminated his Petri dishes. After inspecting, he was amazed to find that the mold inhibited the normal growth of the staphylococci. He named this active antimicrobial substance "penicillin"(2). However, it took over a decade before penicillin was introduced as a treatment for bacterial infections(3). The success of antibiotics has been impressive. At the same time, excitement about them has been tempered by a phenomenon called antibiotic resistance. This is a problem that surfaced not long after the introduction of penicillin and now threatens the usefulness of these important medicines(1). Antimicrobial Resistance (AMR) occurs when bacteria, viruses, fungi and parasites change over time and no longer respond to medicines which makes infections harder to treat and increases the risk of disease spread, severe illness and death. As a result of drug resistance, antibiotics and other antimicrobial medicines become ineffective and infections become increasingly difficult or impossible to treat(4). Today, there are very few novel antibiotics under development. At the same time antibiotic resistant bacteria that survive antibiotic treatment are becoming more and more common, making available antibiotics ineffective. Thus, we are inevitably facing a major health problem(3). Antibiotic resistance has many causes; one of the main causes is antibiotic residue in animal-food products. So, it has a wide impact on human health, animal health and the environment.

How Do Antibiotics Work?

There are two types of antibiotic activation. The first is bactericidal antibiotics which include Aminoglycosides, Beta lactams, Fluoroquinolones, Glycopeptides, Lipopeptides, Nitroimidazoles and Nitrofurans. The second is bacteriostatic antibiotics which include Glycylcyclines, Lincosamides, Macrolides, Oxazolidinones, Streptogramins and Sulphonamides. (2) At the end, bacteria will be destroyed by the immune system. The three main antibiotics' mechanisms of action are the below:

1. To destroy cell wall and membrane of bacteria
 - a. Cell wall synthesis inhibitors: Cell wall of bacteria consists of peptidoglycan. Antibiotics bond with Penicillin Binding Proteins (PBPs) which relates with the generation of cross linking in peptidoglycan. The drugs under this group are Penicillins, Cephalosporins, Carbapems, Monobactams and Glycopeptides.

b. Inhibitors of membrane function: Function of Cytoplasmic membrane is to control the movement of bacterial substances. When the membrane is disturbed, substance will leak out from the bacteria cell. It makes bacteria die. The drug under this group is Polymyxins.

2. To Inhibit or disturb nucleic acid synthesis

a. Nucleic acid synthesis inhibitors: Nucleic acid consists of DNA and RNA.

i. Antibiotics that inhibit the RNA synthesis will disturb the transcription process that prevents the creation of mRNA in bacteria and makes bacteria unable to create protein in the next consequence.

The drug under this group is Rifampin.

ii. Antibiotics that inhibit the DNA synthesis:

- Drugs prevent the function of DNA gyrase which are enzymes that unwind the DNA strand. Stress in cells causes death in bacteria. The drug under this group is Quinolones.

- Drugs that directly affect DNA such as Metronidazole, the produg. When drugs go into the bacteria cell, it will change the form that functions to activate and generate nitro anionic radicals which bond with DNA strands in bacteria; resulting in a damage of DNA.

b. Folic acid metabolism inhibitors: Function of Folic acid is cofactor in the DNA synthesis. When antibiotics prevent creation and function of Folic acid, this results in a disturbance to the creation of genetic material of bacteria and stops growth. The drugs under this group are Sulfonamides and Trimethoprim.

3. To inhibit or disturb protein synthesis in bacteria cell

a. Protein synthesis inhibitors: Function of ribosome is to create protein in bacteria cells. Bacteria have 70S ribosomes which are composed of a 30S subunit and 50S subunit.

i. Antibiotics inhibit the 30S ribosomal subunit. The drugs under this group are Aminoglycosides and Tetracyclines.

ii. Antibiotics inhibit the 50S ribosomal subunit. The drugs under this group are Macrolides, Clindamycin, Linezolid, Streptogramins and Chloramphenicol.

Target sites in action of antibiotics have impact specific for bacteria, but not human cells.(5)

Why Do Farmers Use Antibiotics in Livestock?

Antibiotics are drugs to inhibit or kill growth of microorganisms in animal diseases.(6) Generally, the use of antibiotics in livestock is mainly for 3 purposes. The first is for treatment. The second is a prevention of diseases in animals that show clinical signs of an infectious disease and the third is for growth promotion to boost the weight of the animals. The farmers commonly use antibiotics in livestock for prevention of animal diseases and growth promotion.(7)

For the use of drugs as prevention, the drug will be used in weak animals that are prone to infection. Farmers use antibiotics in animals to provide appropriate economical and humane prevention, treatment and controlling of bacterial infection in livestock. On the other side, the majority of farmers are concerned about antibiotics use in animals because they consider it cruel and inhumane of uncaring welfare in animals. Medication is given to the whole herd by mixing it with water or food.(8)

For the use of growth promotion, farmers produce more meat with less feed input through a use of antibiotics. It is mainly in feed additives, however, with the small doses of antibiotics for a long term of usage. This will help animals grow and increase weight because it supports the nutrients intake to be used in accelerating growth more effectively. This is a result of antibiotics functioning to cease or to fight diseases in animals that leads to a lower need in using nutrients to build an immune system so that nutrients can be more used in growth promotion of animals. (7)

Antibiotics Resistance from Livestock

Antibiotic resistance is caused by adaptation of bacteria to antibiotics. So, the efficiency of antibiotics in the treatment is low. Usage of antibiotics in livestock can leave antibiotics residues in meats and food-animal products. Besides, it can contaminate the environment too. Causes of antibiotic residues in animal-food products are: a) The use of illegal drugs in

animal feed, which is not a legally registered drug, b) Wrong drug usage such as wrong doses, c) No discontinuation of medication for the prescribed length of time, d) Failure to detect residues in animals before consumption, e) Unnecessary use of antibiotics or use antibiotics for the wrong purpose.(9)

Antibiotic residues may cause various toxic effects such as transfer of antibiotic resistant bacteria to humans, allergy, immunopathological effects, carcinogenicity, mutagenicity, nephropathy, hepatotoxicity, reproductive disorders, bone marrow toxicity and even anaphylactic shock in humans. (Importance of antibiotic residues in animal food) Unfortunately, the long term effects of antibiotics on human health have not been known yet. Although antibiotics kill bacteria, resistant bacterias are left in animals. Antibiotic resistance in animals can be transmitted to humans by consumption, touch especially by herdsmen, and infection from the environment. In general, certain people with weak immune systems are at increased risk of infection. There is a high risk of contracting antibiotic-resistant bacteria.(9,10)

Solution of antibiotic residues in livestock needs cooperation from the government such as the Department of Livestock Development and private sectors such as herdsmen. The government should enact additional enforcement laws and enforce strictly using the law. Besides, they should campaign to educate the private sector and provide correct knowledge according to academic principles. The private sector should be conscious and follow the right principles, such as the use of antibiotics in livestock that should be controlled by veterinarians and the use of legal drugs. (9)

Principles of Antibiotic Use in Livestock

The use of antibiotics in animals should be limited but considered necessary for animal health and welfare, using “as little as possible, as much as necessary”. Each drug is excreted by animals at different amounts. The amount of drug accumulation in organs, tissues or animal products also differs. So, Maximum Residue Limit (MRL) in meat and animal products has different values. Responsibility of Codex Alimentarius Commission (CAC) is to set international food standards, including to determine the MRL of the drug in meat and milk, with various branch committees such as The Joint FAO/WHO Expert Committee on Food Additives (JECFA) and Codex Committee on Residues of Veterinary Drugs in Foods (CCRVDF). Therefore, antibiotics used in animals should be only antibiotics that meet safety criteria, quality and efficacy and according to the approved and intended uses. When using antibiotics, it should have veterinarian oversight and consultation. Good veterinarians have to be prudent and responsible for a use of antibiotics by taking disease prevention practices into consideration. In addition, all relevant stakeholders should be responsible for the use of antibiotics, such as following the MRL, and collecting reliable data, providing evidence used in developing policies and informing effectiveness of measures associated with prudent use of antibiotics in livestock. (6,11)

Antibiotic Residues in Environment from Livestock

The antibiotic residues from livestock spread through the environment by waste from livestock. Cleaning stables or fish ponds that have antibiotic residues from animal waste can cause antibiotic residues in the environment. Also, the antibiotic given to animals can be residual in the animal digestive system and released from animal waste. And human re-use of this animal waste applied it as fertilizer, leading to direct contamination of the environment with both antibiotic residues and resistant bacteria over water and soil. From the research studies, it has mostly found antibiotic residue in surface water, drainwater, seawater, and marine sediment. In addition, wastewater treatment technology does not completely eliminate antibiotics. This situation is worse in South East Asia as up to 80% of the wastewater is not treated at all. So, the recommendations to reduce antibiotic residues of the global action plan is:

- Increase awareness about antibiotic residues and optimize antibiotic use.
- Use wastewater treatment plants to keep residues entering the environment to a minimum.
- Often monitoring and researching to make new innovations.
- Set policies to improve the usage of antibiotics.

(12,13,14,15)

Antibiotic Residue in Meats in human food

Many studies found that meat in human food has antibiotic residue exceeding the limit of regulation. In 2002, 600 samples were divided into poultry200, pork200, and cow's milk200 from Chonburi, Ayutthaya, Nakhon Pathom, Bangkok and surrounding provinces of Thailand. They found antibiotic residues mostly in pork have exceeded the limit of regulation.

Moreover in 2018, Found 40% of collected sample meat are residue with antibiotics. 32chicken breast and 30chicken liver examples were collected from malls, markets and online stores on 9-15 June 2018 to find antibiotic residue from 3 antibiotic groups i.e..Fluoroquinolone Group, Tetracycline Group and Beta – Lactam Groups. Most samples that have antibiotic residue did not exceed the limit but 5 samples had Enrolfloxacin that must not be residue according to regulation. That made Antimicrobial Resistance (AMR) increase. In 2019, around 700,000 people died because of infection with AMR and the trend will increase to 10 million in 2050. Form the collected samples in Thailand, 61 of pork, 54 of beef and 57 of poultry were found with AMR. Bacteria have drug resistance in poultry 78.9%, in pork 65.6% and in beef 51.8%.

(6,16,17)

How to cope with unsafe food?

Not only do the food that we eat make us healthy, but they can also make us unhealthy. It depends on how good and hygienic the food is. There are many ways to deal with unsafe food or the way to select safe food like:

- To select food from shops that have certified or brand that pass the test is one of the ways.
- Make sure that you self, ingredients and equipment are clean before cooking or consuming. Most bacteria can reproduce and live in many surfaces such as hand equipment and ingredients, cleaning it can make your food safer.
- Do not eat raw food or undercooked food, also food that has been left for a long time. Some bacteria do not die if the temperature is not high enough.
- Use a serving spoon to ladle food onto your plate.

(18)

Additionally, people have to consider food safety and prepare food hygienically by following the WHO i.e. the five keys to food safety including to keep clean, to separate raw and cooked food, to cook thoroughly, to keep food at safe temperature with a use of clean water and safe raw materials, and to choose foods that have been produced without the use of antibiotics for growth promotion or disease prevention in healthy animals. To stop the spread of antibiotic resistance, the medical personnel have to wash hands every time when touching patients and use the principle of sterile technique and aseptic technique to separate patients; however, the medical equipment must be clean and sterilized (19)

Nowadays, food safety is a serious problem so related organization set a new concept to make food safe which is called “ONE HEALTH”

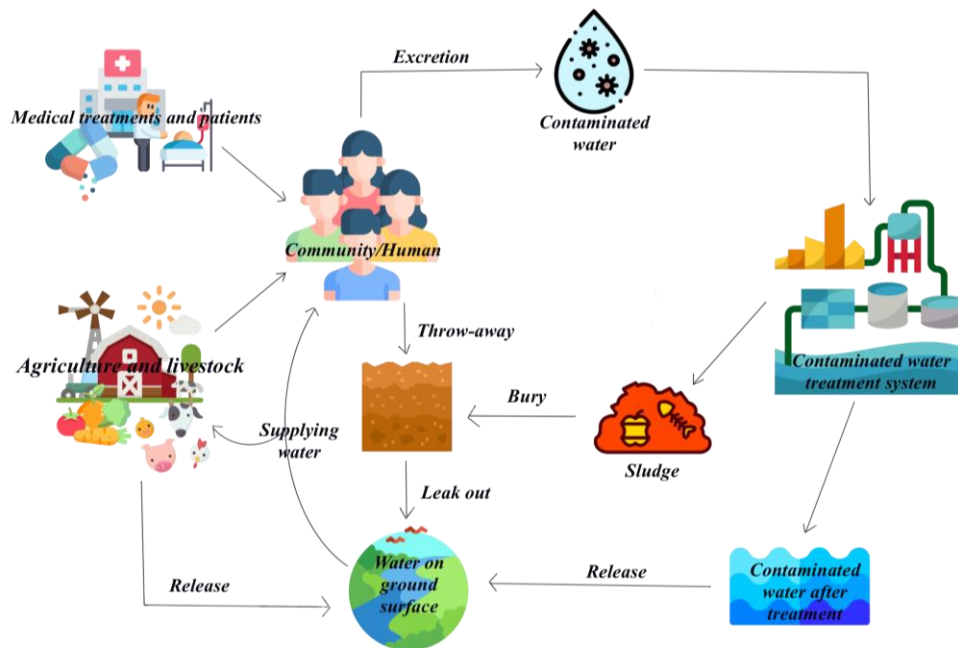
2. ONE HEALTH

ONE HEALTH, which comes from “Our Necessity Encourages Human Environment Animal Living Together Harmony”(20), is animal health, human health, and environmental health. These are intrinsically intertwined and interdependent. The health of one affects the health of all. Nowadays, there are three main organizations that cooperate together. The first one is the Food and Agriculture Organization of the United Nations (FAO). The second is the World Organization for Animal Health (OIE) and the last one is the World Health Organizations (WHO). (21)

Antibiotic resistant is created in humans of many causes, mainly divided as the follows:

1. Medical treatments and patients such as poor infection control in hospitals or clinics, patients not taking antibiotics as prescribed, etc.
2. Agriculture and livestock that produce meats and vegetables that are contaminated with antibiotic resistance residue.(22)

These causes of antibiotic resistance lead to the drug resistant action problem in people in which the residue will be eliminated from the body as excretion in urine and stool. These will be treated through the wastewater treatment system and then released as the excretion residue and wastewater after treatment. The excretion residue will be buried under ground which can be dissolved and leaked into the river and canal. For wastewater, it will be released into the river and canal as well whereas the drug resistance is also released from the activities of agriculture and livestock into the river and canal too.(23)



Antibiotic Resistance Cycle (Adapted from references NO. 23,24)

Antibiotic resistance is importantly related to ONE HEALTH because it has been obviously found that the problem of drug resistance arises from many factors related to humans, animals, and the environment. Therefore, the effective solution should embed all three factors, not only any one of them.

3. CONCLUSION

Antibiotics in livestock are to treat, prevent and promote growth. Antibiotics are still important for animal diseases as well as human diseases. However, improper use may lead to antibiotic resistance which has a wide impact on human health, animal health and the environment. Antibiotics resistance is a part of food safety. As "you are what you eat", the safe food that you eat will keep you healthy. Therefore, responsible use of antibiotics in livestock is very important.

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