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FOOD PROTECTION CONNECTION

ANTIMICROBIAL RESISTANCE

FOOD SAFETY IMPLICATIONS AND BEYOND

BY KATIE SABATINI, RD, LDN

ANTIBIOTICS ARE ANTIMICROBIAL DRUGS used to treat or prevent bacterial infections, and are grouped according to their mechanism of action against bacteria. Antimicrobial resistance (AMR) occurs when microorganisms that cause infections adapt and change after exposure to prevent an antimicrobial from working against it, making it ineffective against the disease.

With AMR, the microorganism evolves to become more, or completely, resistant to an antimicrobial agent which could previously treat it effectively. These microorganisms that develop resistance to antimicrobials are sometimes referred to as *superbugs*.

AMR is a naturally-occurring genetic change; however, misuse and overuse of antimicrobials is accelerating this process. New resistance mechanisms are constantly emerging and spreading, and when this occurs, existing antibiotics/antimicrobials become ineffective to treat common diseases and infections persist in the body, increasing the risk of spread to others as well as the possibility of disability and death. Additionally, without effective antimicrobials for prevention and treatment of infections, medical procedures become more high-risk to the patients and AMR increases hospital length of stay, increases the need for intensive care, and raises the overall costs associated with health care. For this reason, the World Health Organization (WHO) classifies AMR as a global public health concern.

In 2010 more than 63,000 tons of antibiotics were consumed by livestock worldwide, and in 2011 the CDC reported that AMR was increasing the economic burden on the American healthcare system, costing in excess of $20 billion a year. An additional $35 billion can be attributed to societal costs, and more than 8 million additional days spent in hospitals.

The first true antibiotic, penicillin, was discovered by Sir Alexander Fleming in 1928, as inhibiting disease-causing staphylococci. By 1951, there were reports of resistance following experimental feeding of turkeys with streptomycin, followed by an association of resistance to tetracycline antibiotic fed to chickens.

The earliest concerns about the development of antibiotic resistance in human pathogens and recommendations to ban use in animal feeds were discussed in a report to the UK parliament in 1969. A direct correlation of resistant pathogens into the human food chain, and their transfer to humans through contaminated food, is tied to *Salmonella enterica*, associated with poultry and poultry meat products. By 2006, all feed additives containing antibiotics were banned across Europe.

The emergence of AMR in the food production industry represents a serious food safety risk with multidimensional implications on food safety and public health as well as food security, animal health and welfare, the environment, climate, and socioeconomic development. The use of antibiotics for prevention, treatment, and growth promotion purposes in crop production enables their release in natural ecosystems and a large portion of these antibiotics are not inactivated. Rather, they retain their biologically active form and enter groundwater, soil, or wastewater treatment plants leading to environmental pollution and establishing the environment as a reservoir for the spread of AMR across the farm-to-plate continuum. They also lead to food safety issues associated with the presence of antibiotic residues.

Food plays an important role in the development and spread of AMR because their presence in our agricultural production systems and food chains is a potential route of exposure for everyone. AMR is an increasingly serious threat to global public health that requires action across all government

sectors and society. The potential consequences of AMR include reduced food production, reduced food security, greater food safety concerns, higher economic losses to farm households, and contamination of the environment.

Negative effects of AMR on human and animal health can have major social, economic, and environmental impacts. With the growing awareness of the rise in AMR, many countries have phased out the use of antimicrobials for animal growth promotion and are focusing on optimizing the use of antimicrobials in disease prevention and treatment. And, while there has been a reduction in use of antibiotics for disease prevention due to better awareness of the potential long-term adverse effects of AMR, in large emerging countries, antimicrobial usage continues to be high, largely due to the impact on animal growth and profit margins on the farm, as well as the lack of affordable alternative interventions.

THE WORLD FOOD SUMMIT (2012) recognized that food systems must contribute to address and prevent infectious diseases, and curb AMR.

Global efforts to combat the risks posed by AMR depend on effective national action plans. Most countries have taken a "One Health" approach in developing their national action plans covering human health, animal health and the environment, which provides a framework for collaboration to combat and slow AMR. To reduce the emergence of AMR bacteria in the food chain, measures must be taken upstream. Antimicrobial agents should be used judiciously and in accordance with professional advice in both human and veterinary medicine, as well as farming applications. Sustainable food production systems where high productivity is not over-reliant on antibiotic use is crucial to the quantity and quality of farmed food. The World Food Summit (2012) recognized that food systems must contribute to address and prevent infectious diseases, and curb AMR.

Raising awareness of the issue of AMR in the food safety and food chain context is vitally important, so that producers and government authorities are aware of the implications and improvements that can be made in food control systems, animal rearing, plant production and health, to address AMR. Good food safety management practices can minimize the transmission of AMR in food, however many countries lack the infrastructure, regulation and resources necessary to implement and monitor food safety through a national food control system, which is a necessary prerequisite to address AMR. Management of AMR in the food chain is complex and requires the implementation of good practices starting at primary production and continuing through to consumption. Imprudent use of antimicrobials throughout the food chain contributes to AMR. Controlling the transmission of AMR through foods is similar to controlling other hazards in food. We need to manage AMR populations in foods and pay attention to environmental factors that may contribute to resistance development.

The Codex Alimentarius has standards aimed at preventing the development of AMR and minimizing its transmission through the food chain, which is a great starting point for the creation of an AMR monitoring and testing regime in produce crops. Additionally, existing veterinary drug residue monitoring programs already utilized in some countries can be used as the basis for development of effective monitoring and surveillance systems to track the use of antimicrobials and the spread of AMR through the food chain. Also, the Food and Agriculture Organization of the United Nations (FAO) is an organization that leads international efforts to defeat hunger and improve nutrition and food security and has an AMR laboratory mapping tool. This helps countries assess their national surveillance and laboratory capacities in addition to providing governments with support and training on how to set up and effectively operate veterinary drug residue monitoring programs, which also can be applied to produce.

A growing world population and the resulting increase in demand for food is putting added pressure on our food supply chains and systems. Food security is achieved 'when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.' However, 700 million people live in extreme poverty, approximately one-third of all food produced is wasted, and 800 million people are living in hunger, which puts pressure on earth's resources. To meet the growing demand for food, farmers look for ways to improve crop yield and one way is through the use of antimicrobials/antibiotics contributing to AMR through food crops.

WE NEED TO MANAGE AMR POPULATIONS IN FOODS and pay attention to environmental factors that may contribute to resistance development.

There is widespread and sometimes indiscriminate misuse and overuse of antibiotics worldwide. 'The antibiotic paradox' describes the premise that *the misuse of antibiotics destroys their curative power.* Prudent application of existing available antibiotics needs to be emphasized, and antimicrobial codes of conduct should be developed to extend the usefulness and efficacy of antibiotic agents for future generations.

REFERENCES

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KATIE SABATINI, RD, LDN | katie.sabatini@littleleaffarms.com

Katie Sabatini is the Food Safety and Quality Assurance Manager for Little Leaf Farms LLC, where she puts into practice her passion for food safety. Sabatini has comprehensive knowledge of industry food safety application, implementation, and management. She received her BS in nutrition & dietetics from the University of Delaware, and is actively completing her MS in food safety and food law at Michigan State University.

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III

This **Level III** article assumes that the reader has a thorough knowledge of the topic and ability to apply the concepts. The desired outcome is to evaluate application and create continuous quality improvement into best practice.

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1. Antibiotics are grouped according to:
   A. The bacteria they target
   B. Their genetic makeup
   C. Their mechanism of action
2. AMR occurs when microorganisms _____ and _____, making the antibiotic ineffective against the disease it's intended to treat.
   A. Change/multiply
   B. Adapt/change
   C. Adapt/grow
3. World population growth, resulting in increased demand for food and added pressure on the supply chain, results in farmers needing to meet this growing demand for food, and one way is through:
   A. Increased use of antimicrobials
   B. Decreased use of antimicrobials
   C. Increased veterinary drug monitoring
4. AMR's economic burden on the U.S. healthcare system is more than $20 billion annually due to:
   A. Increased length of stay
   B. Increased level of care
   C. Both A and B
5. What was the first antibiotic?
   A. Penicillin
   B. Cephalosporin
   C. Amoxicillin
6. The "One Health" approach to developing a framework for collaboration to combat and slow AMR covers:
   A. Animal health, plant health, and the environment
   B. Human health, environmental health, and medical treatment
   C. Human health, animal health, and the environment
7. Microorganisms that develop resistance to antimicrobials are also called:
   A. Bad bugs
   B. Superbugs
   C. Megabugs

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