WHY POULTRY PRODUCERS SHOULD WORRY ABOUT BACTERIAL SEX

Horizontal gene transfer (bacterial sex) is good for bacteria, but potentially bad for humans. An awareness of how it can contribute to antibiotic resistance is important for planning future production strategies.

by Abigail Salyers

After being bombarded with the sordid scandals that have been making the news lately, many of us have become tired of seeing sex stories in the media. Yet, a type of sex you may never have heard of—bacterial sex—has been dominating recent debates over regulations that soon may limit the ability of poultry producers to use antibiotics as growth promoters. Like it or not, some awareness of what bacterial sex is and how it contributes to antibiotic resistance is important for planning future production strategies.

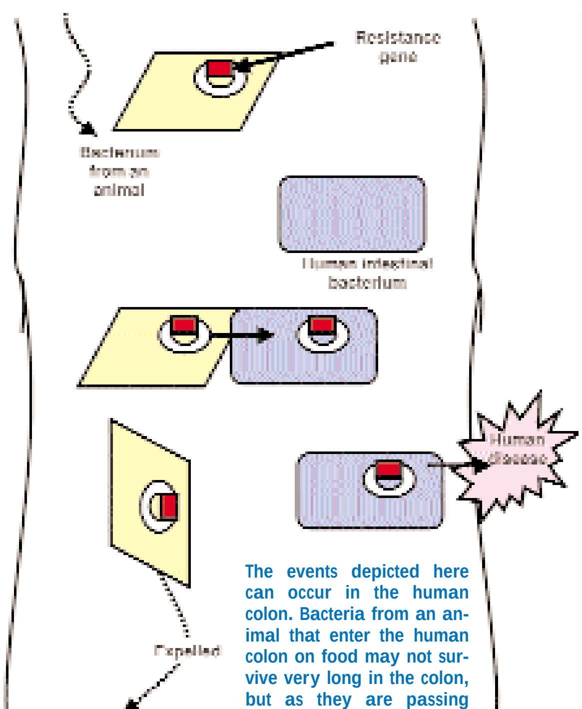
What is bacterial sex? Bacterial sex (also called horizontal gene transfer) is a term used to describe the ability of bacteria to acquire genetic material from other bacteria. Of greatest concern is the acquisition of genetic material that makes bacteria resistant to antibiotics. Bacteria can become resistant to antibiotics by mutation, but that is a long process that may take years to complete. It also is a costly process for bacteria because many of them die as a result of unsuccessful mutations.

Acquiring a pre-formed segment of genetic material from another bacterium, a segment that contains the plan for a successful strategy for resisting antibiotics, not only is much safer for the bacterium but also takes only hours to accomplish. What is good for bacteria, however is bad for humans because antibiotics are important drugs for keeping bacteria under control.

Effect on Poultry Production

In January 1999, the FDA held its first hearings on a document that, if it becomes policy, could have a major effect on the way poultry producers run their production units. A key part of the document is the classification of antibiotics into four classes. Class I, the class that probably would be banned as growth promoters, contains antibiotics that cross-select for resistance to a human use antibiotic that is the only one still effective against some important human infections. Most of the antibiotics currently used as feed additives fall into this class.

The FDA was responding to public concerns about the increased ability of bacteria to resist the effects of antibiotics. Because of the importance of antibiotics for human medicine, public and government officials tend to overreact and to react emotionally rather than rationally when the integrity of antibiotics is threatened.



The events depicted here can occur in the human colon. Bacteria from an animal that enter the human colon on food may not survive very long in the colon, but as they are passing through, they can transfer their antibiotic resistance genes to bacteria that normally live in the intestine. Some of the human intestinal bacteria can cause serious infections if the colon is perforated in an accident or during surgery. Transfer of a resistance gene from one bacterium to another takes less than an hour.

If you have been following the media coverage of antibiotic-resistant salmonella, you may be surprised to learn that FDA was not concerned primarily about salmonella. Salmonella infections usually are self-limiting and rarely are treated with antibiotics. Rather a very different type of bacterium, Enterococcus, has become the focus of concern. During the last decade, Enterococcus has emerged as a major cause of life-threatening post-surgical infections. Enterococcus normally resides in the human colon, so it is available to contaminate surgical wounds. Most post-surgical infections are caused by bacteria carried on the patient's or health care worker's body. A person who carries antibiotic-resistant Enterococcus in his or her intestine is at increased risk of contracting an Enterococcus infection that would be difficult to treat. The FDA was concerned that Enterococcus and other intestinal bacteria that can cause serious infections would become resistant to antibiotics due to the use of antibiotics on the farm and then move through the food supply into the intestines of humans.

There is considerable scientific evidence that antibiotic-resistant Enterococcus strains from animal intestines are making their way into foods being sold to consumers. The burning question is this: Will the bacteria from animals be able to compete with the bacteria already occupying the human intestine, or will they be eliminated from the intestine fairly rapidly? At least some scientific studies suggest that the bacteria from animals would be eliminated. This is where bacterial sex comes into the picture. Even if the bacteria from animals were to remain in the human intestine only briefly, there still would be plenty of time for them to transfer their resistance genes to the resident bacteria.

How readily do bacteria in the human intestine acquire antibiotic-resistance genes from bacteria that are just passing through? Laboratory studies have shown that Enterococcus and other bacteria in the human intestine can acquire DNA from a variety of food-borne and water-borne bacteria, and that this process occurs rapidly if the conditions are right. But are the conditions right in the human colon? The best way to answer this question is to look at bacteria isolated from the human intestine for evidence that they have acquired resistance genes from other bacteria. The rationale is much the same as the rationale behind the statement: If you are carrying Smith's business card, chances are good that you have come into contact with Smith and acquired the card from him. Scientific studies have found in Enterococcus strains some of the same resistance genes found in bacteria carried on foods. Thus, transfers can occur in the intestine. What is lacking is evidence showing this process occurring in real time.

What's at Risk

Antibiotics are chemical compounds that kill or inhibit the growth of bacteria. Antibiotics target certain bacterial activities such as their ability to make essential proteins. Bacteria become resistant to antibiotics by learning how to destroy the antibiotic, denying the antibiotic access to its target, or by modifying the target so that the antibiotic no longer works. Instructions for becoming resistant are encoded in the bacterial genome.

Antibiotics are important not only for treating diseases such as ulcers or pneumonia but are the essential foundation for most of modern medicine. Surgery is widely available and relatively risk-free because infections acquired during the surgical process by about 5 percent to 10 percent of patients are treatable by antibiotics. Cancer chemotherapy, which temporarily destroys the patient's immune system as well as fighting the tumor, increases the patient's risk of acquiring a bacterial infection. Antibiotics help protect patients during this vulnerable period. As bacteria become more resistant to antibiotics, hospital costs rise and patients stay in the hospital longer. Ultimately, if resistance become widespread, certain medical procedures that are now taken for granted will have to be curtailed or ceased entirely.

Steps in Resistance

Hypothetical steps involved in movement of antibiotic-resistant bacteria from farm to the consumer are shown here. Asterisks indicate the steps supported by the most scientific evidence.

- Step 1. Antibiotic use on the farm selects for antibiotic-resistant bacteria.*
- Step 2. Antibiotic-resistant bacteria from the intestines of animals contaminate meat or vegetables, which are then purchased by consumers.*
- Step 3. Antibiotic-resistant bacteria colonize the intestines of consumers or transfer their resistance genes to bacteria normally found in the human intestinal tract.
- Step 4. A person colonized by antibiotic-resistant bacteria is at higher risk for later development of an untreatable post-surgical infection.*

Preparing for The Future

At present, there is good scientific evidence to support the contention that agricultural use of antibiotics selects for resistant bacteria and resistant bacteria reach the human intestine through the food supply. There is less evidence to support the contention that transfer of resistance genes to bacteria normally found in the intestinal tract occurs or that colonization of the human intestine with antibiotic-resistant bacteria will cause a significantly higher risk of human treatment failures. Given that the chain of evidence is incomplete, producers and their representatives are justified in asking just how much of a human risk agricultural use of antibiotics actually poses.

In my opinion, it is not going to be enough simply to deny there is a problem. As more evidence accumulates to support the contention that bacteria in the food supply can help bacteria in the human intestinal tract become more resistant to antibiotics, pressure to regulate antibiotic use in agriculture is going to increase. Arguing that overuse by physicians is a greater contributor to increased antibiotic resistance of bacteria than agriculture is not going to help much. This statement is true, certainly, but the public does not see use of antibiotics by physicians as optional. Rightly or wrongly, the average member of the public views agricultural use of antibiotics—especially as feed additives—as optional.

If I were a producer, I would be facing the antibiotic use issue squarely and begin to look for other options. If antibiotics prove to be truly irreplaceable in some cases, the public needs to be convinced that this is the case. A good faith effort to formulate principles for prudent use of antibiotics, comparable to those being formulated by physicians groups, also would help convince the public that producers are concerned about antibiotic overuse. Several farm organizations are currently working on such guidelines. If these new guidelines prove to be simply a justification for continuing business as usual, however, they will be less effective than they could be.

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