ANTIBIOTIC RESISTANCE AND HUMAN HEALTH: INDUSTRIAL FARM ANIMAL PRODUCTION

Fred Dolgin, M.D., August 24, 2008

One of the benefits of preparing a presentation is learning new information. I volunteered to talk about this aspect of food and environment because I was superficially aware that our current use of antibiotics in farm animal feeding may lead to antibiotic resistance. I wanted to increase my understanding of this subject. The topic of antibiotic resistance and human health has been part of my work as a family physician for the past thirty years. I also serve on the infectious disease and the pharmacy and therapeutics committees at Flagler Hospital.

The current concept of antibiotics began in 1943 according to Webster's Collegiate Dictionary. It is defined as "a substance produced by or a semi-synthetic substance derived from a microorganism and able to dilute in solution to inhibit or kill another microorganism." The targeted bacteria, virus, or fungus can cause infection in humans or animals. Different from antiseptics such as bleach, which can also kill microorganisms, antibiotics can be safely administered to humans and animals by mouth, on the skin, or by injection.

Humans and animals possess many mechanisms to fight infection, which promoted survival for eons before the advent of antibiotics around sixty years ago. One mechanism is stomach acid which can kill many orally ingested microorganisms. Another is intact skin which is impermeable to most microorganisms. Most importantly, the immune system contains multiple pathways to identify invading pathogens (microorganisms that cause infection) and mobilize chemicals and cells than can help remove them from the bloodstream, gut, urinary tract, and airway. vaccines help the immune system target specific pathogens such as tetanus, polio, and influenza

In the past one hundred years some of the greatest achievements in reducing rates of infection were due to improved sanitation and clean drinking water. Food and Drug Administration and local public health regulations and inspectors have helped make food processing and restaurants safer, although not totally free of contamination. On an individual level, careful hand washing can help prevent the transmission of pathogens from one person to another.

Nonetheless, antibiotics are an important tool to fight infection and have saved millions of lives. One of the original antibiotics is penicillin. Thirty years ago when I was in training, strep pneumonia, the leading bacterial cause of pneumonia, was exquisitely sensitive to small doses of penicillin. Fortunately, *Strep pyogenes* the cause of strep throat, is still sensitive to penicillin. However, according to the antibiogram, produced annually by Flagler Hospital based on the resistance pattern of isolated organisms, only 56% of strep pneumonia isolates were susceptible to penicillin in 2007. *Staph aureus,* a leading cause of skin and wound infections, was also initially sensitive to small doses of penicillin. Over time, staph aureus became resistant to penicillin so that semi-synthetic penicillins, such as methacillin, were developed to treat staph aureus

infections. Currently methicillin resistant staph aureus, or MRSA, accounts for over 23 of the isolates of staph aureus at Flagler Hospital and to varying degrees at hospitals throughout the world.

How does antibiotic resistance occur? According to the PRINCIPLES AND PRACTICE OF INFECTIOUS DISEASE, a respected textbook, "antibiotic agents exert strong selective pressures upon bacterial population favoring those organisms that are capable of resisting them." These changes include point mutations and rearrangement of large segment of DNA or RNA, which code for proteins that can interfere with the way antibiotics inhibit or kill bacteria. Another mechanism is acquisition of foreign DNA by plasmids, which are genetic elements that are located apart from the chromosome. Plasmids can transfer genetic information between both similar and dissimilar pathogens, thus facilitating widespread antibiotic resistance.

The antibiogram at Flagler Hospital indicates the growing resistance of many pathogens to newer antibiotics. The development of new expensive powerful antibiotics to overcome antibiotic resistance is increasing the cost of treating many infections, and some infections are becoming increasingly difficult to treat even with newer antibiotics. One way to approach this problem is to avoid treating viral infections such as upper respiratory infections and bronchitis with antibiotics. Another way is to choose the correct antibiotic, dose, and duration of treatment. Many treatment guidelines are readily available to help health care professionals.

The next part of my talk will focus on the relationship between industrial farm animal production and antibiotic resistance. My experience with rural America is minimal. In the 1950s, which I attended elementary school, I remember a field trip to a local dairy farm. We drank fresh milk with our lunch on picnic tables, watched cows graze in pastures, and learned how milk was produced from cows. Over the past 50 years, raising farm animals has changed from small family farms to large industrial operations. Most of my information was obtained from a report by **The Pew Commission on Industrial Farm Animal Production** funded by The Pew Charitable Trusts through a grant to the Johns Hopkins Bloomberg School of Public Health. One of the school's research fellows, Jay Graham, co-authored a report titled *Antibiotic Resistance and Human Health* and spoke before the Senate Health, Education, Labor and Pensions Committee earlier this year.

Currently large numbers of pigs, chickens, and cows are raised in closed barns. One industrial operation can contain more than 25,000 pigs, 100,000 chickens, or 10,000 cows. Feeding and watering are automated processes. Movement is restricted. Feces and urine are flushed from troughs to open cesspool holding ponds. **Antibiotics are added to the feed mixture purportedly to enhance growth and therefore profit. The sub-lethal doses continually fed to animals facilitate the emergence of antibiotic resistance bacteria, which can easily spread to other animals in crowded conditions.** I want to emphasize that this use of antibiotics is different than the administration of therapeutic doses of antibiotics to sick animals. (*Emphasis by website manager)*

The amount of antibiotics used on farms annually is reported to be between 17.8 to 24.6 million

pounds. I**n the U.S, 70% of the antibiotics used each year are fed to farm animals. In North Carolina, farm animals consume more antibiotics than is used to treat all humans in the U.S.**

These antibiotic resistant bacterial colonize the intestines of farm animals, contaminate their feces, and collect in retention ponds. Groundwater contamination can seep into aquifers and affect drinking water. There is no regulation of the treatment of animal waste. **These farms produce three times the amount of manure than humans do.** In addition to antibiotic resistant bacteria, runoff from these farms also contains antibiotics, hormones, pesticides, and heavy metals. Contaminated manure can be used as fertilizer for crop fields. Industrial farm workers can become infected or colonized with antibiotic resistance bacteria and transmit these bacteria to their family and neighbors. Currently these agricultural workers are not subject to federal and state industrial regulation, exposure monitoring, and injury-disease reporting.

Despite improved regulation of the meat-packing industry after the publication of Upton Sinclair's *The Jungle* in 1906, contaminated meat can transmit antibiotic-resistant bacteria to workers and consumers. These bacteria may not be susceptible to new antibiotics that have been licenses for agricultural use before human use. In the European Union, where non-therapeutic use of antibiotics in farm animals has been banned, studies have documented decreasing prevalence of antibiotic-resistant bacteria in humans.

The practice of adding antibiotics and other agents to animal feed to promote animal growth is rationalized by increased profit. Recent studies found that the financial benefits to agribusinesses was minimal and could be achieved more safely by better management of animal hygiene. **More importantly, the cost of non-therapeutic use of antibiotics is borne by society and not calculated in the retail price of meat and poultry.** The National Academy of Sciences estimated that increased health care cost due to antibiotic-resistant bacteria was $13/person/year while eliminating antibiotics from animal feed would increase consumer cost less than $10/person/year. These studies were in 1998 and 1999.

Interestingly, greenhouse gases, such as methane, carbon dioxide, and nitrous oxide, released from industrial farm animal production facilities, especially the intestines of animals, account for 18 percent of all human-caused greenhouse gas emissions. this is more than all the cars, trucks, buses, trains, and planes produce.

The Pew Commission made six recommendations:

1. Phase out and then ban the non-therapeutic use of antimicrobials.

2. Improve disease tracking and monitoring. The goal is that a US Animal Identification Number will help track food animals "from birth to consumption and include movement, illness, breeding, feeding practices, slaughter condition and location, and point of sale."

3. Improve Industrial Farm Animal Production regulation with regard to animal waste collection, treatment, and disposal.

4. Phase out intensive confinement that restricts natural movement and normal behaviors of animals. Animal welfare is an ethical issue.

5. Increase competition in the livestock market. Antitrust laws should be enforced to help restore the small and mid-size family farm, which was the basis of a thriving rural America.

6. Improve research in animal agriculture. Public funding is needed to avoid the bias inherent in research funded by giant multinational agricultural companies.

What can we do?

1. Eat less meat products.

2. Read labels and buy milk, eggs, and meat not produced with antibiotics in animal feed.

3. Become better informed and talk to others about this problem.

4. Write to legislators to increase regulation of industrial farm animal production and ultimately to ban non-therapeutic use of antibiotics in farm animals.