Chapter Excerpt from the Award-Winning Book CAFO
Leo Horrigan, Jay Graham, and Shawn McKenzie
“Antibiotic Drug Abuse”
ANTIBIOTIC DRUG ABUSE

CAFOs Are Squandering Vital Human Medicines

Leo Horrigan, Jay Graham, and Shawn McKenzie

Antibiotics have been called the “health care miracle of the last 500 years.” However, the rampant use of antibiotics as growth promoters in industrial food animal production has put this health care miracle at risk. In North Carolina alone, the estimated volume of antibiotics used to make food animals grow faster exceeds all U.S. use of antibiotics for human medicine. The result is an ever-increasing prevalence of antibiotic-resistant strains of disease-causing organisms that erode the effectiveness of antibiotics in curing disease in humans.

Alexander Fleming, the scientist who discovered penicillin in 1928, later predicted that inappropriate use of such an antibiotic could lead to the development of resistance by the disease-causing organisms. “The time may come,” Fleming said, “when penicillin can be bought by anyone in the shops. Then there is the danger that the ignorant man may easily underdose himself and, by exposing his disease-causing organisms to nonlethal quantities of the drug, make them resistant.”1 Even in the early years of the antibiotic age, some scientists understood that antimicrobials (a broader term than antibiotics that includes antivirals and antifungals in both natural and synthetic forms) are a generally irreplaceable resource for humanity—in fact, one that could be squandered if used indiscriminately or unwisely.

Antibiotics serve as a critical defense in the fight against numer-
ous infectious organisms that can cause widespread disease and death in humans. The methods that now predominate in industrial food animal production (IFAP)—applying constant “subtherapeutic” doses of antibiotics to the billions of food animals produced each year—facilitate the rapid emergence of antibiotic-resistant strains of disease-causing organisms (e.g., bacteria, often referred to as microbes or pathogens) and compromise the ability of medicine to treat disease. Such inappropriate practices must end.

**THE RISE OF ANTIBIOTIC THERAPY**

The discovery of antibiotics is considered to be among the most important milestones in the history of the public health field. Penicillin, the first antibiotic developed as a medicine, was once hailed as a “miracle drug” because it was so effective in fighting diseases that had long plagued humanity. Antibiotics have been such a successful cure for many infectious diseases that today it is difficult to imagine that in 1900 the three leading causes of death in the United States were pneumonia, tuberculosis (TB), and diarrheal diseases—and that these diseases caused more than 30 percent of all deaths. In fact, in the first decade of the twentieth century, more than 40 percent of all deaths among people ages five to forty-four were caused by infectious diseases, with tuberculosis accounting for more than 25 percent.

Antibiotics became widely available in the 1940s, and by the 1970s only 3 percent of people in these age groups were dying from infectious diseases, owing in large part to effective antibiotic therapy. The World Health Organization (WHO) has referred to the existence and continued effectiveness of antibiotics as the “health care miracle of the last 500 years.”

**ANTIBIOTIC USE IN INDUSTRIAL FOOD ANIMAL PRODUCTION**

No doubt Alexander Fleming would be incensed to discover the methods used today in industrial food animal production. Giving antibiotics to animals in low doses has been found to accelerate growth by making the conversion of feed to weight gain more efficient. As a
Everyday, scientists from government agencies struggle to stay on top of the potential for contamination by such organisms as E.coli, Salmonella, and other bacteria that can result in recalls of tens of millions of pounds of meat annually.
result, antibiotics are used routinely and on a massive scale in IFAP. In North Carolina alone, the volume of antibiotics used as a feed supplement has been estimated to exceed all U.S. antibiotic use in human medicine. These practices have serious consequences. In addition to productivity changes, using antibiotics at subtherapeutic levels in IFAP also promotes the rise of resistant strains of disease-causing organisms. If antibiotic pressure is sustained, even at low levels, those resistant strains of disease-causing organisms have an edge over non-resistant strains when it comes to reproduction and spread.

Through evolutionary adaptation, disease-causing organisms (e.g., \textit{E. coli}) almost always develop resistance to substances that humans exploit to kill them. In other words, they acquire the ability to thwart the toxicity of medicines designed to control them. The widespread and routine use of antibiotic drugs accelerates this evolutionary process, to the point where the declining effectiveness of antibiotics is now considered a serious public health crisis, expressed in the rising incidence of drug-resistant infections.

Recent studies in the Netherlands, \textsuperscript{8} Ontario, \textsuperscript{9} and in Iowa \textsuperscript{10} found the same strain of methicillin-resistant \textit{Staphylococcus aureus} (MRSA) present in both pigs and the people who regularly tend to those pigs, suggesting the disease was transmitted from animal to human. It has been estimated that MRSA killed more than 18,000 people in U.S. hospitals in 2005,\textsuperscript{11} more than died from AIDS. Until recently, MRSA research was mostly focused on health care–associated infections (which have been estimated to account for about 85 percent of MRSA infections),\textsuperscript{12} but so-called community-acquired infections—including those associated with agriculture—are beginning to attract more attention.

While discussion of the issue of declining effectiveness of antibiotics often centers on the importance of ensuring the proper use of antibiotics in human medicine, the fact is that 60 to 80 percent of antibiotic use in the United States is accounted for by IFAP’s use of antibiotics as growth promoters.\textsuperscript{13} A relatively small percentage of antibiotic use in IFAP is to treat sick animals, although the exact percentage is unknown because industry is not required to report these data. Much of what is needed for therapeutic purposes is the direct result of the
IFAP practice of severely crowding large numbers of food animals into small, unsanitary spaces—thereby increasing the chance that diseases will spread through their populations—and feeding animals an unnatural diet (e.g., raising cattle on grains instead of grass). While it has been recognized that crowding, inadequate housing, and unsanitary conditions facilitate the spread of infectious disease in human populations, this knowledge has not been transferred to industrial food animal production.

**RESERVOIRS OF RESISTANCE**

Exacerbating the problem of using antibiotics for food animal growth promotion is the fact that disease-causing organisms can share genes that encode resistance to antibiotics, helping to spur a rapid evolution toward a resistant form. This gene sharing can even occur across different species. Evidence of shared resistance genes has been detected in fecal bacteria found in consumer meat products. Moreover, researchers often focus on specific patterns of resistance in selected disease-causing organisms—a “one bug, one drug” definition of the problem. But this definition discounts the fact that it is the community of genetic resources—what can be called “reservoirs of resistance”—that determines the rate and propagation of resistance. A reservoir of resistance refers to bacteria, both disease-causing and non-disease-causing, that are resistant to antibiotics. These bacteria can carry the genetic material (resistance genes) that may eventually be transferred to an organism that can cause disease in humans. The disease would then be more difficult to treat because of its antibiotic resistance. The large quantities of antibiotics given to food animals are likely creating a “pressure” that fundamentally alters biotic ecosystems, speeding the spread of resistance with few safeguards separating the animals that host these bacteria from the humans who consume the animals.

From a public health perspective, it clearly makes good sense to remove antibiotics from IFAP practices. When antibiotics are not used in food animal production, resistance in disease-causing organisms tends to decrease significantly.
Research reveals that pigs in CAFOs are often colonized by methicillin-resistant MRSA—an antibiotic resistant bacteria believed to be raising health threats to pig farmers, workers, their families and surrounding communities.
BENEFITS VERSUS RISKS

Recent studies call into question the assumed economic benefits of using antibiotics in animal feeds. Historically, economic gains from using antibiotics to promote growth have been thought to justify the expense of the drugs. Two large-scale studies—one with poultry and one with swine—found that the economic benefits were minuscule to nonexistent, and that the same financial benefits could instead be achieved by improving cleanliness in animal houses.19 Even when improvements from growth-promoting antibiotics have been observed, their benefits are completely offset if costs from increased resistance are considered; loss of disease treatment options, increased health care costs, infections that are more severe and persist for longer. These costs are usually “externalized” to the larger society and not “internalized” or captured in the price of the meat.

Industry trade groups argue that using antibiotics in food animal production does not pose a threat to public health.20 But numerous studies support a strong link between the introduction of antibiotics into animal feeds and an increased prevalence of drug-resistant organisms isolated from food animals. Those resistant strains of disease-causing organisms can pose public health threats through food routes and environmental routes.

In the United States and Europe, antibiotic-resistant disease-causing organisms are highly prevalent in meat and poultry products, including organisms that are resistant to the broad-spectrum antibiotics penicillin, tetracycline, and erythromycin.21 Animals supplied antibiotics in their feed contain a higher prevalence of multidrug-resistant E. coli than animals produced on organic farms without exposure to antibiotics,22 and the same disparity shows up when one compares the foods produced by these two styles of production.23

Waste disposal is the major source of antibiotic-resistant disease-causing organisms entering the environment from IFAP facilities. Each year, confined food animals produce an estimated 335 million tons of waste (dry weight),24 more than forty times the mass of human biosolids generated by publicly owned treatment works (7.6 million tons in 2005). In contrast to regulation of human biosolids, there are
no specific requirements for reducing the concentrations of disease-causing organisms in animal waste before it is disposed of, usually on croplands—even though levels of disease-causing organisms, as well as antibiotic-resistant disease-causing organisms, are often higher than in human feces.\textsuperscript{25}

Moreover, resistant \textit{E. coli} and resistance genes have been detected in groundwater sources for drinking water sampled near hog farms in North Carolina, Maryland, and Iowa.\textsuperscript{26} Groundwater provides drinking water for more than 97 percent of rural U.S. populations. In addition, antibiotics used in IFAP are regularly found in surface waters at low levels.\textsuperscript{27}

Resistant disease-causing organisms can also travel through the air from IFAP facilities. At swine facilities using ventilation systems, resistant disease-causing organisms in the air have been detected as far away as 30 meters upwind and 150 meters downwind.\textsuperscript{28}

Farm workers and people living near IFAP facilities are at greatest risk for suffering the adverse effects of antibiotic use in agriculture. Studies have documented their elevated risk of carrying antibiotic-resistant disease-causing organisms.\textsuperscript{29}

\textbf{THE ETHICS OF ANTIBIOTIC USE}

The obverse of antibiotic resistance is antibiotic effectiveness, which can be thought of as a resource that might well be finite and nonrenewable. Once a disease-causing organism develops resistance to an antibiotic, it may not be possible to restore its effectiveness. Declining antibiotic effectiveness can be equated with resource extraction.\textsuperscript{30}

As antibiotics are increasingly understood in this way, their use for nontherapeutic purposes becomes ethically dubious at best. If antibiotic effectiveness can be “exhausted” by nontherapeutic use, can society justify expending a large percentage of this precious resource for the sake of growth promotion in food animals? The very notion of antibiotic effectiveness as a natural resource is a new concept, so it is not surprising that there has been very little public discussion about the ethical implications of depleting this resource for nonessential purposes.
POLICY CHANGE

In 2003, the American Public Health Association (APHA) said that “the emerging scientific consensus is that antibiotics given to food animals contribute to antibiotic resistance transmitted to humans.” APHA, the world’s largest public health organization, also remarked that “an estimated 25–75 percent of feed antibiotics pass unchanged into manure waste.”

For its part, the World Health Organization (WHO) has recommended that “[governments should] terminate or rapidly phase out the use of antimicrobials for growth promotion if they are also used for treatment of humans.”

For an industry that has become accustomed to using antibiotics as growth promoters, the idea of stopping this practice might seem daunting. But consider the case of Denmark, which in 1999 banned the use of antibiotics as growth promoters. In 2002, WHO reported that the termination of antimicrobial growth promoters in Denmark has dramatically reduced the food animal reservoir of enterococci resistant to these growth promoters, and therefore reduced a reservoir of genetic determinants (resistance genes) that encode antimicrobial resistance to several clinically important antimicrobial agents in humans.

WHO also reported that there were no significant differences in the health of the animals or the bottom line of the producers. The European Union has followed suit with a ban on growth promoters that took effect in 2006.

The Pew Commission on Industrial Farm Animal Production recommended that the United States “phase out and ban use of antimicrobials for nontherapeutic (i.e., growth-promoting) use in food animals.” It also called for no “new approvals of antimicrobials for nontherapeutic uses in animals,” and for investigating those already approved.

THE TRAGEDY OF THE MEDICAL COMMONS

Antibiotics can best be viewed as a part of “the commons”—like air, water, and soil—in the sense that they are derived (in most cases)
from naturally occurring substances produced by organisms as a defense against other organisms. The for-profit pharmaceutical companies, however, are largely controlling this particular “commons” as they manufacture antibiotics for various uses, including growth promotion in animal agriculture. A crucial human health benefit is being compromised for the sake of an economic benefit—slightly lower costs in producing meat—and one that might well be illusory.

In a sense, our animal agriculture industry has become a stand-in for the “ignorant man” that Alexander Fleming warned against. The industry is underdosing animals with antibiotics—some of them medically important ones—allowing resistance to develop more rapidly among disease-causing organisms.

Efforts to phase out the use of medically important antibiotics in agriculture are a step in the right direction, but the problem of antibiotic resistance caused by agriculture should be viewed as symptomatic of a larger problem—the unsustainable nature of an industrial model in food animal production. While in the short term, steps can be taken to mitigate the harm done by this practice—such as improved monitoring of antibiotic use and surveillance to track the spread of antibiotic resistance—the long-term solution is to move away from the industrial model entirely.

The misuse of antibiotics is only one of myriad problems that are inherent in industrial food animal production, but it is among the problems that present an acute and immediate risk to human health. The issue calls for bold and comprehensive policy change that can be guided by science but driven by an informed public. A failure to act will allow the “ignorant man” to continue to threaten our health.
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