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Pharming Chickens: It's Time For The U.S. Poultry Industry to Demonstrate Antibiotic Stewardship

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OVERVIEW

The widespread use of antibiotics in poultry production is breeding drug-resistant bacteria that threaten human health.

Over the past 50 years, as poultry farms became larger and more concentrated, farmers began using antibiotics to prevent disease and speed growth in broiler chickens (chickens raised for meat) living in these crowded and stressful conditions. The industry today remains dependent on their widespread use, and antibiotics are frequently given to birds that are not sick. When antibiotics are routinely given to entire flocks, resistant bacteria are likely to survive and proliferate. These resistant bacteria can even share resistance genes with other bacteria. A large and growing body of evidence shows that antibiotic-resistant bacteria are frequently found on poultry products and in the air and water around poultry facilities and can be carried by poultry workers as well. These bacteria can cause foodborne illness and other types of bacterial infections. Ailments caused by drug-resistant bacteria can be harder to treat—patients can be subject to longer hospital stays, complications, and even death if treatment fails. The Centers for Disease Control and Prevention and many other health authorities have sounded the alarm about rising rates of antibiotic resistance, pointing to overuse and misuse by livestock producers and in human medicine as the cause of this dangerous problem. It's time for the poultry industry to demonstrate stewardship of these important medicines, and help protect their effectiveness for humans.

The good news is that there are proven alternatives to the routine use of antibiotics. A combination of practices such as water acidification; use of prebiotics, probiotics, and other feed additives; improved sanitation and litter management; use of vaccines; improved genetics; and lower bird densities, among others, are effective at preventing disease and reducing the need for antibiotics. Several studies indicate that nontherapeutic uses of antibiotics in U.S. broiler production can be avoided at a cost of pennies per pound of chicken produced.

Antibiotics should be used sparingly in poultry production to treat sick animals and, in rare circumstances, for controlling disease outbreaks. They should always be used under the supervision of a veterinarian, and never to make up for poor growing conditions. Congress and the Food and Drug Administration (FDA) should issue binding regulations to protect antibiotics used in human medicine, and producers and large buyers of poultry products should commit to standards in line with that goal. Consumers should also consider antibiotic use in their purchasing decisions. Poultry producers, policymakers, buyers at large food companies, and consumers must all take action to ensure that these medicines are used safely.

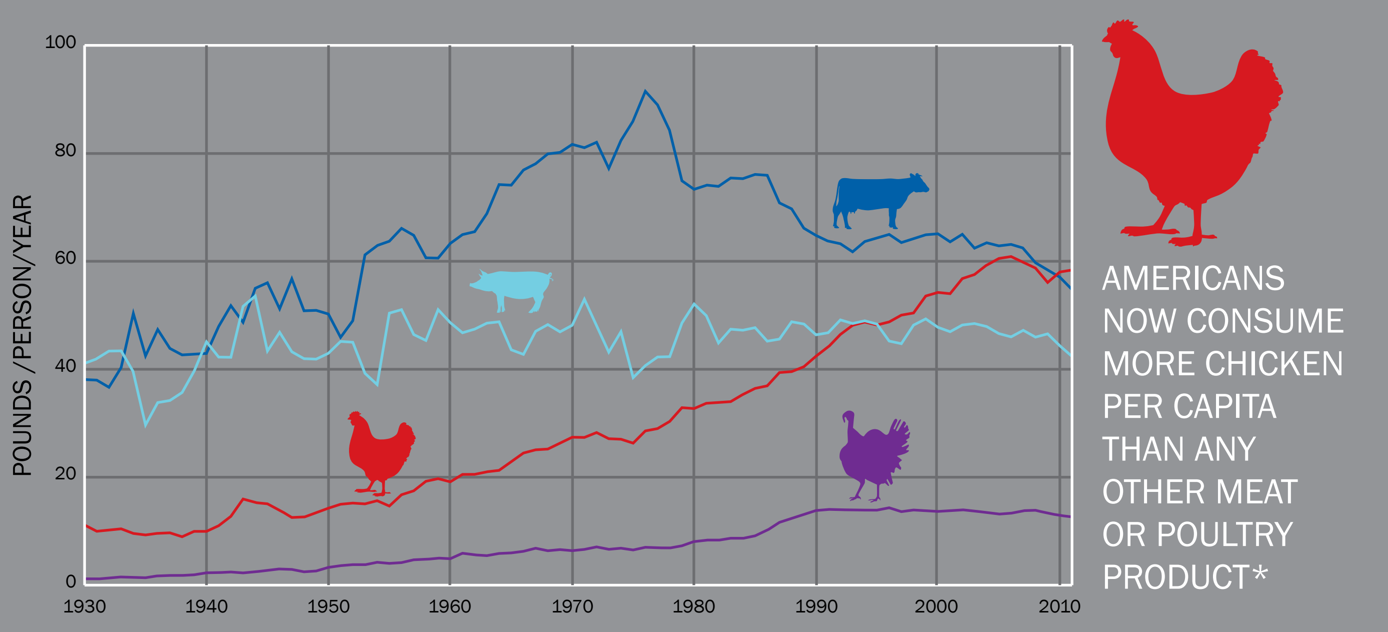
AMERICANS EAT MORE CHICKEN THAN ANY OTHER TYPE OF ANIMAL PROTEIN

In 2010, chicken replaced beef as the primary source of animal protein in U.S. diets.[1] Americans now eat three times more chicken than they did in 1960—almost 60 pounds per person every year. This is largely because it has become cheaper to eat chicken than either beef or pork, and because chicken has been touted as a healthier choice.[2] In 1960 it took 63 days to grow a 3.4-pound broiler that was sold for $3.24 per pound (in 2011 dollars); in 2011 it took 47 days to grow a 5.8-pound broiler sold at $1.29 per pound.[3] The increase in size and production rates of U.S. poultry operations has been driven, in part, by this increased demand. Unfortunately, many of these structural changes in the U.S. poultry industry have contributed to negative consequences for human and environmental health. These include surface water and groundwater contamination; air pollution; and increased dependency on antibiotic use which contributes to the spread of antibiotic-resistant bacteria that threaten human health.[4]

OVERUSE OF ANTIBIOTICS IN U.S. BROILER PRODUCTION BREEDS ANTIBIOTIC-RESISTANT BACTERIA THAT THREATEN HUMAN HEALTH

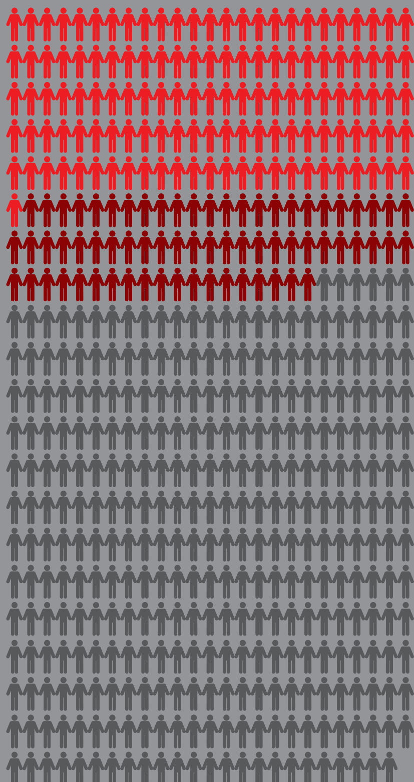
Bacterial resistance to antibiotics has become a public health crisis of worldwide proportions—so much so that the World Health Organization says it is “threatening to undo decades of advances in our ability to treat disease.”[5] In a recent report, the Centers for Disease Control and Prevention stated, “Up to half of antibiotic use in humans and much of antibiotic use in animals is unnecessary and inappropriate and makes everyone less safe.”[6] Livestock use accounts for 80 percent of all antibiotics sold in the United States and 70 percent of all sales of antibiotic classes that are also used in human medicine.[7] Industry reports, trade literature, scientific studies, and reports from USDA and FDA scientists suggest that antibiotics continue to be widely used in poultry production, although no government agency collects or discloses data on the volume of antibiotics used in this industry[8] (See Table 1 for classes of antibiotics approved for use in broiler production that are also used in human medicine). A large body of recent research ties the routine use of antibiotics for disease prevention or to promote growth in livestock to the emergence of antibiotic-resistant bacteria, or “superbugs.”[9]

Figure 1: U.S. meat and poultry consumption, per capita, 1930–2011



* Data from the USDA ERS Food Availability Data System

SALMONELLA HEIDELBERG OUTBREAK: 2013 – 2014

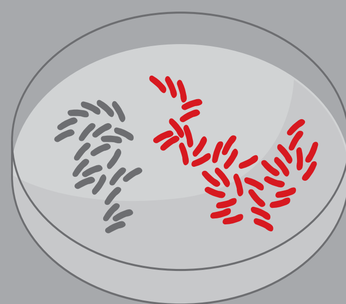


524
PEOPLE HAVE FALLEN ILL

37%
OF THESE CASES WERE HOSPITALIZED

13%
DEVELOPED BLOOD INFECTIONS

These percentages were calculated based upon the subset of cases for which there was available information in April of 2014.



CLINICAL SAMPLES FROM 61 PATIENTS IN THE OUTBREAK WERE TESTED AND OVER HALF WERE INFECTED BY A *SALMONELLA* RESISTANT TO AT LEAST ONE COMMONLY PRESCRIBED ANTIBIOTIC.

2013 *Salmonella* Outbreak linked to Foster Farms

In October 2013, the U.S. Centers for Disease Control and Prevention (CDC) announced an outbreak of *Salmonella* Heidelberg that the agency linked to the consumption of Foster Farms chicken. As of April 2014, 524 people had fallen ill, 37 percent of cases were hospitalized, and 13 percent developed blood infections. Of 61 isolates tested from patients, CDC reports that 38 (62 percent) exhibited resistance to at least one antibiotic. CDC notes that, while the particular antibiotics the bacteria were resistant to are not used to treat *Salmonella* infections, antibiotic resistance in general may be associated with an increased risk of hospitalization. In addition, based on CDC estimates of *Salmonella* infection under-diagnosis rates, the outbreak may have sickened more than 15,000 people.[a]

Source: United States Centers for Disease Control and Prevention, *Multistate Outbreak of Multidrug-Resistant Salmonella Heidelberg Infections Linked to Foster Farms Brand Chicken*, January 16, 2014), www.cdc.gov/salmonella/heidelberg-10-13/.

[a] CDC estimates that for every for reported case of *Salmonella* infection, 29.3 cases go undiagnosed, and uses this multiplier to create more comprehensive estimates of foodborne illness in the U.S. The figure cited in the text was obtained by multiplying the total number of reported illnesses in the most recent *Salmonella* outbreak (524) by 29.3 = 15,353. See United States Centers for Disease Control and Prevention, *Foodborne Illness Acquired in the United States – Major Pathogens*, Volume 17, Number 1-January 2011, Table 2, http://wwwnc.cdc.gov/eid/article/17/1/p1-1101-t2.htm.

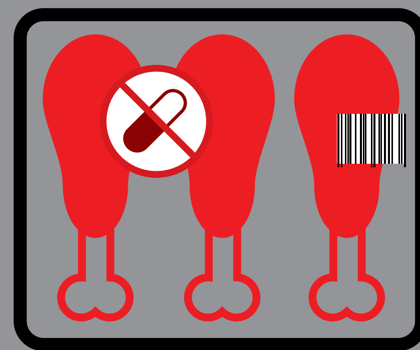
Certain antibiotics are often first injected into broiler eggs to prevent infection when they are vaccinated.[10] Others may then be routinely used to prevent and control common infections such as salmonellosis, necrotic enteritis, and coccidiosis in chicks and adult birds.[11] Antibiotics may also be used to make broilers grow faster with less feed.[12] Many antibiotics are approved by the FDA for use in feed or water to prevent disease and promote growth (see Table 1)—a practice that is likely to breed antibiotic-resistant bacteria.[13] These bacteria travel into supermarkets and homes on the chicken sold at the grocery store, spread to farmers and poultry workers who handle the birds, and travel downwind and downstream from poultry facilities in air, water, and poultry litter (a mixture of excrement, feathers, feed, and other material that is cleaned out of poultry houses). Antibiotic-resistant bacteria can then lead to foodborne illness, increase the risk of other illnesses among farmers and poultry workers, and contribute to the growing abundance of antibiotic-resistant bacteria on the farm, in the environment, and in our communities.

ACCORDING TO 2011 DATA ON CHICKEN SAMPLED FROM GROCERY STORE SHELVES AS PART OF THE NATIONAL ANTIMICROBIAL RESISTANCE MONITORING SYSTEM (NARMS),

26% OF CHICKEN SAMPLED HAD RESISTANT *CAMPYLOBACTER*

53% OF CHICKEN SAMPLED HAD RESISTANT *E. COLI*

9% OF CHICKEN SAMPLED HAD RESISTANT *SALMONELLA*



(RESISTANT TO ONE OR MORE ANTIBIOTICS.)

Source: National Antimicrobial Resistance Monitoring System 2011 Retail Meat Report.

Antibiotic-resistant bacteria are found on poultry products, contributing to foodborne illness and other infections

Scientists and government agencies routinely find antibiotic-resistant bacteria on animals at slaughter and on the fresh retail meat sold in grocery stores. According to 2010 data from the USDA's animal arm of the National Antimicrobial Resistance Monitoring System (NARMS), 25 percent of *Campylobacter*, 64 percent of *E. coli*, and 42 percent of *Salmonella* bacteria isolated from birds arriving at slaughterhouse facilities were resistant to two or more antibiotics.[14] Additionally, antibiotic-resistant *Campylobacter*, *E. coli* and *Salmonella* were found on 26 percent, 53 percent, and 9 percent, respectively, of all tested fresh chicken samples at supermarkets. Of these resistant samples, 45 percent of the *Salmonella* isolates were resistant to three or more antibiotics, and one in five *Campylobacter* isolates were resistant to the first-line antibiotic ciprofloxacin.[15]

Although pathogens on meat are typically destroyed when meat is cooked, they nevertheless infect large numbers of people, usually as a result of cross contamination, handling prior to cooking, or improper cooking. Bacterial pathogens from poultry are estimated to have caused more than 652,000 illnesses between 1998 and 2008, more than any other food commodity.[16] In addition to gastrointestinal illness, resistant foodborne pathogens can result in more serious infections. In a recent *Salmonella* outbreak that was linked to Foster Farms chicken, some of the strains that caused the outbreak were resistant to several commonly prescribed antibiotics in human medicine. While the CDC notes that the particular antibiotics the bacteria were resistant to are not used to treat Salmonella infections, antibiotic resistance may be associated with an increased risk of hospitalization. (see callout box).[17] There is also growing evidence that food, and chicken in particular, may be among the causes of urinary tract infections (UTIs), which are often caused by *E. coli*.[18] Foodborne urinary tract infections caused by resistant bacteria might lead to additional risks and costs associated with medical treatment.[19] In general, when harmful bacteria are resistant to antibiotics, patients face increased risk of longer hospital stays and treatment failure, as well as the need to use other drugs with greater health risks and side effects. These factors, in turn, result in higher costs of treatment.[20]

Medical illustration of non-typhoidal *Salmonella*

© Centers for Disease Control

Antibiotic-resistant bacteria are found on farmers and poultry workers

The health risk from direct exposure to antibiotic-resistant bacteria on food is only part of a greater threat. Many studies have correlated the introduction of antibiotics in poultry production with the emergence of drug-resistant bacteria and subsequent colonization or infection of workers.[21] For example, an early study found that when farmers who previously harbored no tetracycline-resistant bacteria introduced tetracycline feed additives, more than 30 percent of their gut bacteria developed resistance to tetracycline within five months (compared with 6.8 percent of samples from neighbors). When tetracyclines were removed from feed, resistance levels in farmers dropped to near-zero levels.[22] Another study in Maryland and Virginia found that poultry workers were 32 times more likely when compared with other community members to carry gentamicin-resistant *E. coli*; they were also more likely to carry *E. coli* that were resistant to multiple drugs.[23] In addition to just carrying resistant bacteria, studies have found that poultry and meat workers on the farm and in the processing plant are more prone than the general public to infections by methicillin-resistant Staphylococcus aureus (MRSA) and *Campylobacter*, among others.[24] A growing proportion of these infections are resistant to multiple antibiotics, which may make them more dangerous and more costly and difficult to treat.[25]

The Danish Example

Broiler production in Denmark offers a compelling case study for what happens when a whole country bans the use of antibiotics on birds that are not sick. Over the past two decades, producers successfully transitioned away from all nontherapeutic use of antibiotics with no significant changes in mortality or production, and only a minor increase in feed conversion (that is, a decrease in growth efficiency). This transition was accomplished through minor changes in management and animal husbandry, including more frequent house cleaning, improved ventilation, and reduced animal densities.

Source: H. Emborg et al., "The Effect of Discontinuing the Use of Antimicrobial Growth Promoters on the Productivity in the Danish Broiler Production," *Preventive Veterinary Medicine* 50 (2001): 53-70. World Health Organization, *Impacts of Antimicrobial Growth Promoter Termination in Denmark*, 2002, www.who.int/gfn/en/Expertsreportgrowthpromoterdenmark.pdf (accessed October 30, 2013). The Pew Charitable Trusts, *Avoiding Antibiotic Resistance: Denmark's Ban on Growth Promoting Antibiotics in Food Animals*, http://www.pewhealth.org/uploadedFiles/PHG/Supporting_Items/DenmarkExperience.pdf (accessed December 9, 2013).

Antibiotic-resistant bacteria from poultry houses contribute to the spread of antibiotic-resistant bacteria in the air, water, and soil

Antibiotic-resistant bacteria from poultry houses can spread into the environment.[26] For example, the resistant bacteria can escape poultry houses on pests, such as flies, in the air that is blown from poultry house fans, and on trucks transporting poultry to slaughterhouses.[27] Poultry litter (a mixture of excrement, feathers, feed, and other material that is cleaned out of poultry houses) is another important way in which antibiotic-resistant bacteria can escape the farm. Because antibiotic-resistant bacteria abound in poultry litter and persist in the litter when it is stored, resistant bacteria can be transferred to soil or water (or even to crops and produce) when this litter is spread as fertilizer on fields.[28] Several studies have found resistant bacteria in the surface water and groundwater near poultry facilities.[29] Soil can become an important reservoir of antibiotic-resistant bacteria as well.[30]

Antibiotic-resistant bacteria from poultry production can contribute to rising rates of antibiotic resistance

When antibiotic-resistant bacteria from production of poultry or other livestock spread to our air, water, communities, and food supply, they can share their resistance genes with other bacteria and promote resistance to antibiotics that were not used in raising the animals. Researchers have shown that bacteria in soil can exchange resistance genes with other bacteria, that resistance genes can be passed directly from farm bacteria to pathogenic bacteria in the community, and even that ingested antibiotic-resistant bacteria can share resistance genes with other bacteria inside the human gut.[31] For instance, a recent study in Pennsylvania found that people living closer to swine farms and fields treated with swine manure had higher rates of antibiotic-resistant skin infections, including MRSA.[32] There may be similar associations with proximity to poultry facilities. Many scientists now refer to a growing "reservoir" of antibiotic resistance in our communities and environment.[33] In an era when essential antibiotics are failing to work, the existence of such a reservoir is troubling, to say the least.

ALTERNATIVES TO ANTIBIOTIC USE IN BROILER FACILITIES EXIST AND ARE SCALABLE

The good news is that there are proven alternatives to the routine use of antibiotics, and there is evidence that an increasing number of U.S. poultry integrators (large poultry companies that contract with individual producers to provide the labor and facilities to raise birds) have adopted antibiotic-free production systems or are reducing use.[34] In early 2014, the fast food company Chick-Fil-A declared its intention to transition to serving only chicken raised without antibiotics within the next five years.[35] Perdue Farms, the 4th largest poultry company in the United States[36] claims to have already transitioned 80 percent of their hatcheries to antibiotic-free (as reported by National Public Radio in February 2014).[37] These changes are largely due to increasing consumer demand for either poultry raised without antibiotics or organic poultry products.[38] Producers can likely achieve significant public health benefits by eliminating non-theraputic uses (i.e. disease prevention and growth promotion uses) of antibiotics as a less-costly alternative to eliminating *all* antibiotics, but there is no existing label or standard by which to assess or recognize antibiotic stewardship short of no antibiotic use.

Producers can reduce or eliminate the need for non-therapeutic antibiotic use through a combination of technologies and improved management practices such as:

- **Drinking water acidification.** Adding certain acids to drinking water can significantly reduce the amount of harmful bacteria in young chicks and adult broilers and can selectively promote colonization by "good" bacteria.[39]
- **Use of prebiotics and probiotics.** Giving birds pre- and probiotics at critical stages of the growth cycle can preemptively help establish a healthy environment in the gut, which makes colonization by pathogenic bacteria less likely.[40]
- **Feed supplements and additives.** While many supplements and additives are still considered experimental, antibiotic-free broiler operations frequently use a variety of natural feed supplements, such as oregano, thyme, and various oils that may improve animal health or help prevent disease.[41]
- **Improved management of poultry house and litter conditions.** Cleaning out litter more frequently, managing litter moisture, and improving airflow can help reduce disease pressure from bacteria such as *Salmonella*, *Campylobacter*, and *E. coli*.[42]
- **Vaccination.** A live vaccine for coccidiosis results in enhanced immunity against *Eimeria* spp.[43] Mixtures of live and heat-killed vaccines have been used in broiler breeders to boost immunity against *Salmonella* in hens and their progeny.[44]
- **Improved genetics.** Breeding birds to be more resilient and resistant to disease can help reduce the need for routine antibiotic use.[45]
- **Reduced bird densities.** Reducing the stocking density of broilers in the absence of antibiotics may improve bird health and growth under stress.[46] Average stocking densities in conventional broiler production are around 0.8 square feet per bird,[47] but many integrators may pack birds more densely. Multiple standards, including the National Organic Program and the Global Animal Partnership, recommend more space per bird for improved health and welfare.[48]

THESE ESTIMATES SUGGEST THAT GETTING RID OF ANTIBIOTICS IN CHICKEN FEED AND WATER WOULD COST MERE PENNIES A POUND.

According to survey data from the Agricultural Resource Management Survey of the USDA,[49] 42.4 percent of operations (representing 44.3 percent of production) reported that their contractor/buyer required that broilers be raised without antibiotics in their feed or water unless the birds are ill.[50] This is consistent with other recent estimates of antibiotic use in feed in U.S. poultry operations.[51] A small but growing share of broiler production is organic or raised without antibiotics, and chicken raised without antibiotics is sometimes sold at a price point competitive with conventional poultry.[52] Brands marketing these products in supermarkets include Fieldale Farms, Springer Mountain Farms, Mary's Chicken, Murray's, Bell and Evans, Miller Amish, and Perdue Farms' Coleman Natural and Harvestland brands.[53]

REDUCING ANTIBIOTIC USE IN BROILER OPERATIONS IS NOT EXPENSIVE

Economic studies suggest that the extra financial benefit that broiler producers get from using antibiotics in broiler feed is small, and some studies suggest there might not be any benefit at all. In 1976, the first study that looked at the cost of a ban on antibiotics in feed found that retail broiler prices would likely go up in the short term by about 2.2 percent.[54] In 1999 the National Research Council estimated that eliminating antibiotics in animal feed would increase the retail price of chicken by 1.3-2.6 percent, or 2 to 4 cents per pound. At the time, this translated to an increase in cost for the average consumer of an additional $1 to $2 per year (or $1.40-$2.80 per year in today's dollars).[55] One recent study suggested that producers may be *losing* money (about 0.09 cent per chicken) by feeding birds antibiotics,[56] and the Danish example (see callout box) suggests that increased costs of transitioning away from antibiotic use were negligible for broilers. Finally, a study by USDA economists that looked at data from farmer surveys estimated that broiler grow-out operations that are required to use no antibiotics in feed or water are paid grower fees 2.1 percent higher, on average, than the fees paid to traditional operations. They speculate that this is due to higher costs of production and management at the grower level when no antibiotics are used.[57] Existing cost estimates concentrate on the costs of eliminating non-therapeutic use in feed and water (and do not include the costs of eliminating other non-therapeutic uses, such as the injection of broiler eggs with antibiotics during vaccination). Nonetheless, these estimates suggest that getting rid of antibiotics in chicken feed and water would cost mere pennies a pound.[58] Current retail prices for antibiotic-free chicken are higher than this estimated cost, but some of this difference may have to do with other attributes of antibiotic-free chicken brands (e.g. "free-range", "Vegetarian-fed", and others), as well as other factors affecting poultry markets and consumer demand.

THE PATH FORWARD

Classes of antibiotics used in human medicine should be used only for therapeutic purposes in poultry production, not for disease prevention or growth promotion, and always under the supervision of a veterinarian.[59] Using antibiotics infrequently to treat sick animals or control a disease outbreak (i.e., therapeutic use) is appropriate to maintain animal health and welfare. While the FDA has issued voluntary guidelines to address growth promotion uses of antibiotics,[60] the guidelines fail to address prevention uses and may have little impact on the problem of routine antibiotic use on animals that are not sick. Many current uses can simply continue under the label of prevention. Both Congress and the FDA have a responsibility to take binding regulatory action to ensure judicious use of antibiotics. Meanwhile, poultry producers and large food buyers should commit to adhering to production practices and procurement standards that support these goals. Consumers, in turn, can vote with their wallets by rewarding producers that are getting the job done with fewer antibiotics. Labels to look for include "USDA Organic"[61] or "No antibiotics administered," (or similar claims such as "No antibiotics ever"), especially if the claims are accompanied by "USDA process-verified." Together, producers, consumers, large buyers, and government agencies can help reduce the threat to human health posed by antibiotic-resistant bacteria, while ensuring that our poultry remains affordable and safe to eat.

Table 1: Classes of Medically Important Antibiotics Approved for Use in the U.S. Broiler Industry[a]			
DRUG CLASS	**USE IN POULTRY**	**USE IN HUMANS[b]**	**LEVEL OF IMPORTANCE IN HUMAN MEDICINE**
Aminoglycosides	Disease prevention and treatment	Treatment of *Listeria* infections, staph infections (heart tissue) Treatment of *Pseudomonas* infection (e.g., lung infection, surgical complication)	Critically important (WHO) Highly important (FDA)
Cephalosporins	Disease prevention and treatment	Treatment of bacterial meningitis, pneumonia	Critically important, 3rd- or 4th-generation cephalosporin (WHO) Critically important (FDA)
Lincosamides	Growth promotion	Treatment of bacterial vaginosis, post-operative wound infections, some *Clostridium* infections	Highly important (WHO) Highly important (FDA)
Macrolides	Disease prevention and treatment; growth promotion	Treatment of *Campylobacter* infection, whooping cough, contaminated traumatic wounds	Critically important (WHO) Critically important (FDA)
Penicillins	Disease prevention and treatment; growth promotion	Treatment of bacterial meningitis and complicated Urinary Tract Infections	Critically important (WHO) Highly important (FDA)
Polymixins	Disease prevention and treatment	Treatment of highly resistant *Klebsiella* infections or multiresistant *Acinetobacter* infection	Critically important (WHO) Highly important (FDA)
Streptogramins	Growth promotion	Treatment of MRSA infections	Highly important (WHO) Highly important (FDA)
Sulfonamides	Disease prevention and treatment	Treatment of urinary tract infections, foodborne illness due to *Salmonella*, etc.	Highly important (WHO) Critically important (FDA)
Tetracyclines	Disease prevention and treatment; growth promotion	Treatment of gonorrhea, chlamydia, pneumonia	Highly important (WHO) Highly important (FDA)

WHO criteria:[c]

1: "An antimicrobial agent which is the sole, or one of limited available therapy, to treat serious human disease."

2: "Antimicrobial agent used to treat diseases caused by either: (1) organisms that may be transmitted to humans from non-human sources, or (2) human diseases causes by organisms that may acquire resistance genes from non-human sources."

Critically Important: 1 + 2. Highly important: 1 or 2. Important: Neither 1 nor 2.

FDA criteria:[d]

1: "Antimicrobial drugs used to treat enteric pathogens that cause foodborne disease."

2: "Sole therapy or one of few alternatives to treat serious human disease or drug is essential component among many antimicrobials in treatment of human disease."

3: "Antimicrobials used to treat enteric pathogens in non-foodborne disease."

4: "No cross-resistance within drug class and absence of linked resistance with other drug classes."

5: "Difficulty in transmitting resistance elements within or across genera and species of organisms."

Critically Important: 1 + 2. Highly Important: 1 or 2. Important: 3 and/or 4 and/or 5.

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a U.S. Department of Health and Human Services, Food and Drug Administration, *Approved Animal Drug Products*, 2013, www.accessdata.fda.gov/scripts/animaldrugsatfda/.

b David Gilbert et al., *The Sanford Guide to Antimicrobial Therapy 2010*, Antimicrobial Therapy, Inc., 2010.

c World Health Organization, *Critically Important Antimicrobials for Human Medicine, 3rd Revision*, 2011, apps.who.int/iris/bitstream/10665/77376/1/9789241504485_eng.pdf.

d U.S. Department of Health and Human Services, Food and Drug Administration, *Guidance for Industry No. 152, Evaluating the Safety of Antimicrobial New Animal Drugs with Regard to Their Microbiological Effects on Bacteria of Human Health Concern 2003*, www.fda.gov/downloads/AnimalVeterinary/GuidanceComplianceEnforcement/GuidanceforIndustry/ucm052519.pdf.

Endnotes

1 Janine Bentley, "U.S. per capita availability of chicken surpasses that of beef," Amber Waves 10 (2012), www.ers.usda.gov/media/909951/chickenavailability.pdf (accessed October 23, 2013).

2 In 2010, chicken prices were $1.67/lb. lower than beef prices, on average, and $0.67/lb. lower than pork prices. Bentley, *supra* note 1. For an example of the medical profession's focus on "lean meats and poultry," *see*, e.g., Alice Lichtenstein et al., "Diet and lifestyle recommendations revision 2006: a scientific statement from the American Heart Association Nutrition Committee," *Circulation* 113 (2006): 82-96; *also see* "Dietary approaches to stop hypertension (DASH) approach," (among others), in U.S. Department of Agriculture, U.S. Department of Health and Human Services, *Dietary Guidelines for Americans 2010* (2010), www.health.gov/dietaryguidelines/dga2010/DietaryGuidelines2010.pdf (accessed October 23, 2013).

3 Average CPI in 1960 was 29.6, average CPI in 2011 was 224.939; therefore real retail price of chicken in 1960 (2011 dollars) was 0.427*224.939/29.6=$3.24/lb. *See* National Chicken Council, "U.S. Broiler Performance," www.nationalchickencouncil.org/about-the-industry/statistics/u-s-broiler-performance/ (accessed October 20, 2013). National Chicken Council, "Wholesale and Retail Prices for Chicken, Beef, and Pork," www.nationalchickencouncil.org/about-the-industry/statistics/wholesale-and-retail-prices-for-chicken-beef-and-pork/ (accessed October 20, 2013). Economic Research Service, "Meat Price Spreads," United States Department of Agriculture, www.ers.usda.gov/data-products/meat-price-spreads.aspx#.UmbllxAwf64 (accessed October 20, 2013). U.S. Department of Labor, Bureau of Labor Statistics, "Consumer Price Index," ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt (accessed October 20, 2013).

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6 Centers for Disease Control and Prevention, *Antibiotic Resistance Threats in the United States, 2013*, 2013, p. 31, www.cdc.gov/drugresistance/threat-report-2013/ (accessed October 10, 2013).

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