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Should the United States Adopt a Policy Against the Use of Antibiotics for Growth Promotion in Food-Producing Animals?

By

Wendy Bernadette Cuevas-Espelid
Degree to be awarded: MPH
Career MPH

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Committee Chair -- Jean O'Connor Date

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Committee Member -- Ali Khan Date

____
Melissa Alperin, MPH, CHES Date
Chair, Career MPH Program

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Wendy Bernadette Cuevas-Espelid

B.S., University of Rochester
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Thesis Committee Chair: Jean O’Connor, JD, DrPH

An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements of the degree of
Master of Public Health
in Prevention Science
2011

ABSTRACT

Should the United States Adopt a Policy Against the Use of Antibiotics for Growth Promotion in Food-Producing Animals?
By Wendy Bernadette Cuevas-Espelid

There is a large debate within the United States over the use of antibiotics in food producing animals as growth promoters. This method of agricultural practice was started during the industrialization of food animals in order to prevent many of the illnesses that were contracted during rearing, transportation and other highly stressful activities. However, animal husbandry played a major part and still plays an important role in the susceptibility of animals to infectious agents. Dirty housing and water, poor ventilation and overcrowding are obvious conditions that can be catastrophic, for any living species, in terms of infectious agents that can proliferate. The low dose therapy of antibiotics was implemented to prevent infections among livestock but this came with a cost to the public health in terms of antibiotic resistance and the subsequent transfer to humans. This project will explore the federal laws implemented in the United States and the evidence based studies that strengthen the argument of the link between the use of antibiotics and resistance with subsequent transfer to humans. Analysis of the federal laws and policies relating to antibiotic use in animals are the main components of this investigation along with recommendations for the agricultural industry. The analysis of the federal laws will examine the most recent congressional hearings and testimonies from key witnesses (veterinarians and medical doctors) residing in the United States and globally. The results of this study will allow for a strong argument to abolish the use of antibiotics for growth promotion in food producing animals. The AVMA is strongly against any ban on the use of antibiotics as growth promoters because they do not believe there is strong enough evidence to support a link between usage and the development of resistance with transfer to humans. A review of the literature supports that the use of antibiotics as growth promoters is a public health concern not just within the United States but on a global level. Recommendations and examples of farms and countries that do not employ this practice will be described.

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Chapter 1

Introduction and rationale

Antibiotic use in food producing animals has and still is a large debate within the United States. Concomitantly, there is much concern on an international level with an increase in the intensification of food animal production as the demand for animal protein sources is necessary to feed the growing global population, (FAO, 2009). The implications to animal health and public health are very serious in light of the fact that there have been an increased number of cases with resistant bacteria that show genetic origin from animals.

Dr. David Love, a scientist at the Johns Hopkins Center for a Livable Future, says, "if producers are reliant on the use of antibiotics to produce animals in a highly concentrated way, it means that the design of these farms makes them breeding grounds for diseases," (Loglisci, 2011). Dr. Love goes on to stating that "is the unwise use of antibiotics for growth promotion in animal production, which compromises antibiotics, a precious resource used to protect the public's health."

The economic costs associated with a national ban in the United States are under question by many and believe that it would cause hardship amongst farm production units and lead to higher food prices. But, considering that the issue has become a public health concern, a remedy to rectify the present day agricultural policies is warranted.

The following list depicts the hypothetical steps involved in the movement of antibiotic – resistant bacteria from farm to the consumer:

1. Antibiotic use on the farm selects for antibiotic- resistant bacteria

2. Antibiotic-resistant bacteria from the intestines of animals contaminates meat and produce that are purchased by consumers
3. Antibiotic-resistant bacteria colonize the intestines of consumers or transfer their resistance genes to bacteria normally found in the human intestinal tract.
4. Person colonized by antibiotic-resistant bacteria is at higher risk for later development of an untreatable post-surgical infection, (Salyers, 2004).

The scientific evidence exists demonstrating the selective properties of bacteria that evolve to become resistant. And the numerous cases of farm production workers and family members that have suffered from resistant enteric infections should be cause for alarm. There appears to be a lack of appreciation of the animal health costs to antimicrobial resistance, the methods of food animal rearing and a lack of accountability for poor animal husbandry.

Problem statement

The use of antibiotics in farm producing animals as growth promoters has instigated a large debate within the United States. The leading health agencies in the US and European Union and World Health Organization agree that the link between the low-level use of antibiotics in farm animals and the increase in bacteria resistant to the same or similar antibiotics administered to humans is serious enough to ban their sub-therapeutic use, (WHO, 2011). In June 2001, the American Medical Association adopted a resolution opposing all sub-therapeutic use of antibiotics in farm animals, (Res. 508, 2001).

The Food and Drug Administration is continuing to look at possible restrictions on the use of antibiotics in livestock. Margaret Hamburg of the FDA told a House subcommittee in March 2010, that antibiotic resistance is one of the nation's “foremost public health concerns” and there are clear linkages between the problem and the use of the drugs in farm animals, (Des Moines Register, 2010).

Theoretical Framework

This study discusses the public health issue of antibiotic resistance and the transfer of resistant bacteria from food producing animals to the general population. The idea that a policy change in the way food producing animals are raised would be simple is an understatement. Is it possible to implement a social behavioral theory to veterinarians and food producers with positive results? There are fundamental changes regarding methods of animal husbandry, the medical protocols designed to address infectious diseases, and the availability of medications need to be addressed in order for production units to work according to new policy changes.

Many farmers and production units have been raising livestock in a similar fashion for years with incremental changes along the way. Implementing a new way of livestock rearing may or may not be met with great resistance.

In terms of economics, it would be expected that financial gains and /or losses would be concomitant with a policy change. It is not the intention of a new legislative bill to put farmers and production units out of business.

It will be difficult to change the opinions of many within the agricultural industry regarding the use of antibiotics and the impending threat to public health. Changing the views will be one of the most difficult challenges faced by policy makers and leaders within the industry.

The fundamental changes that could occur within the agricultural field in the United States should follow the process implemented in Europe, in particular Denmark that has had great success with the abolishment of growth promoters. As skeptics in the United States continue to argue against the ban, observational learning through the experience in Denmark can serve as an excellent role model. Reinforcements to successful production units provide continued confidence and pride in the job that is being accomplished. It would seem intuitively obvious that positive reinforcement to production units would help in maintaining efficient production and ethical treatment of animals as well as pride in the work that is being conducted.

Production units that have proven success while maintaining high standards of animal husbandry should be used as examples for the skeptics. Two farms that have great notoriety in the United States are Applegate Farms and the Niman Ranch. They both agree that food producing animals should be raised humanely, animal husbandry standards are set high, and the use of antibiotics as growth promoters is not necessary, (Applegate, 2009) and (Niman, 2008).

Stephen McDonnell, the CEO of Applegate Farms has been raising food producing animals for over 20 years. They raise animals without antibiotics or hormones and the method of rearing allows freedom to exhibit natural behaviors. McDonnell stated in an interview with Katie Couric of CBS News, February 2010, “We use too many antibiotics; we use too many growth promotants. The singular focus is to create cheap meat. That's not always the best thing for the health of the Americans who buy it. We think with some subtle changes - giving them more space, feeding them a good diet, and not stressing them out by growing them too quickly - you don't even need to use antibiotics”. Applegate farms support a network of over three hundred small family farms. They promise that within their organization:

- Animals are never given antibiotics. Instead, they give them space, fresh air, and a healthy diet.
- Their livestock eat a completely vegetarian diet with no animal by-products. Cattle are grass-fed, as nature intended. Hogs and poultry are fed a grain diet that includes corn, soy, barley, and flax.
- Their animals are never given hormones or artificial growth promotants. They grow at their natural rate, (Applegate Farms, 2009).

Niman Ranch also is an example of using agricultural methods that do not utilize sub-therapeutic antibiotics. Their mission states that 'Niman Ranch and its U.S. farmers and ranchers raise livestock traditionally, humanely and sustainably.' Niman Ranch has been in the agricultural business for over 30 years and has been at the forefront supporting sustainable agriculture, animal welfare, U.S. family farmers and ranchers. They have a network of over 650 independent American farmers and ranchers. There is a strict set of protocols that must be adhered to by the independent farmers but this ensures that the mission of the organization is satisfied, (Niman Ranch, 2008).

Purpose statement

The purpose of this study is to identify the problem of antibiotic resistance by understanding the science behind the development of resistance, the studies that have been conducted displaying key evidence of resistance and the policies that are presently under question. The current legislative rulings on the use of antibiotics in food producing animals are not enforced properly and rely on the ability of veterinarians within the agricultural field to make judicious choices for the health of the animals. This has proved to be inadequate since the sale of over the counter antibiotics in feed stores and in developing countries negates the premise behind judicious use, (Gaur, et al 2006). These medications are administered and the amounts are not recorded appropriately for each animal. It was the hope of this paper that the opinions of veterinary experts in the field would be examined to determine if the veterinary community agrees or disagrees with the agricultural methods employed by the United States.

The paper examines the scientific evidence supporting the theory that the use of antibiotic growth promoters in food producing animals does increase the selective pressure for the development of antibiotic resistance. Recommendations to improve these agricultural methods of intensive animal rearing have been provided with examples of production units that have been successful.

It is through the examination of the European countries that have banned growth promoters and the scientific evidence and the success of agricultural units that do not employ the conventional methods of intensive rearing, that the United States should abolish the use of antibiotics as growth promoters in order to prevent the transfer of resistant bacteria from animals to humans.

Research question

In order to determine how the United States could change the conventional agricultural methods of intensive rearing, we need to question what policy approaches and recommendations could most effectively reduce the use of agricultural growth promoter's in food producing animals, and thereby lower the risk of infection with resistant bacteria to human health.

Considering the implications to the human population here in the United States and in developing nations, it is imperative that new approaches to intensive animal rearing should be considered to reduce the risks associated with resistant bacteria.

Significance statement

The general public and federal officials should be concerned about the use of growth promoters in food producing animals. Many have argued that there is insufficient evidence to claim that growth promoters select for resistance among enteric bacteria or at least that these resistant bacteria are the direct cause of human disease. It is known through the scientific literature that the use of antibiotics over time, especially sub-therapeutic doses, promotes resistance and that resistant bacteria are transmitted to humans, (WHO, McEwen, 2011). The United States should not wait in anticipation for increasing evidence of transfer of resistant bacteria from an animal documented to be on growth promoters to a human subject before taking action.

Policy changes need to be made accordingly for the agricultural industry to improve animal husbandry and the methods food producing animals are reared in order to eliminate the use of antibiotics at sub-therapeutic doses. The use of growth promoters should not be a replacement for housing animals in overcrowded conditions. They should be used under the direction of a veterinarian to treat diagnosed infections and not available for purchase over the counter at feed stores.

Changing the practices within the agricultural industry does require policy changes that incite strong opinions from government officials and representatives of the industry itself. “Nationwide, the corporate takeover of traditional family practices is evidenced by the fact that five corporations now control eighty-nine percent of all beef processing operations and four companies control over half of all pork processing operations,"(Head, 2000). These large corporate farms have done well financially because “federal policy and market forces have favored large-scale mechanized and capital-intensive farming as a means of ensuring cheap and plentiful food," (Lustgarden, 1994). “Not surprisingly, institutionalized mistreatment of today's farm animals is inextricably linked to the objectives that pioneered the shift from traditional, small-scale family farms to giant, corporate factory farms, namely efforts to lower production costs, increase efficiency, maximize corporate profits, and generate cheaper food products for society”, (Wolfson, 1996).

A policy change simply will not alleviate the problem of resistant bacteria transfer, but will facilitate a fundamental change in the way the agricultural industry rears, treats and the hopeful development of respect toward the animals. There are no current laws protecting the rights of farm animals. The Animal Welfare Act, 7 U.S.C. §§2131-2159, exempts animals raised for food and fiber or for food and fiber research, (USDA - National Agricultural Library, 2011), so it is at the discretion of management on a production unit as to how the animals will be treated.

Chapter 2

Introductory paragraph

Antibiotic resistance is an emerging problem among the human population. Significant morbidity and mortality are associated with nosocomial infections as well as community acquired infections of antibiotic resistant strains. According to the CDC, in American hospitals alone, healthcare-associated infections account for an estimated 1.7 million infections and 99,000 associated deaths each year, (CDC, 2009). The increasing number of antimicrobial-resistant infections and their costs in the United States, is estimated to be $400 million to $5 billion per year in 1998 (Institute of Medicine 1998) and $16.6 to $26 billion per year in 2009, (Roberts, Hota, Ahmad, Scott, Foster, Abbasi, 2009).

The problem of multiple-drug resistance among bacteria is worsening because of the excessive and indiscriminate use of antibiotics. This practice favors the exclusive survival of bacteria resistant to selective pressures. Although misuse of antibiotics in human medicine is the principal cause of the problem, antibiotic-resistant bacteria originating in animals are contributory factors, with some types of resistance in various species of bacteria, (Barton 2000).

The American Veterinary Medical Association (AVMA) and other veterinarians within the agricultural industry feel there is insufficient scientific evidence to prove there is a correlation between the use of growth promoters in food producing animals and transmission of resistant bacteria to the human population. The AVMA has testified to Congress that they do not support the theory.

Review of Literature

In the late 1940s and early 1950s, the inclusion of antibiotics in feed was implemented when scientific studies began to report a positive correlation between the use of antibiotics in livestock, swine, and poultry with increased rates of animal weight gain (Jones and Ricke, 2003). The two most widely used antibiotics were chlortetracycline and oxytetracycline. Researchers noted as early as the 1950s that antibiotic resistant bacteria were emerging when animals were administered these sub-therapeutic doses, (Finland, 1956). In 1972, US regulators were very concerned and addressed these worries by a report written by the FDAs Task Force on the Use of Antibiotics and Animal Feeds (van Houweling and Gainer, 1978) and an FDA-proposed policy statement (Edwards, 1972).

There was strong reaction in 1972 and 1973 against the proposed FDA policy statement mainly by representatives of the livestock industry, veterinary pharmaceutical manufacturers and animal science researchers, (Gardner, 1973). Today, industry groups continue to influence the regulatory actions of policies surrounding the use of antimicrobials in food animal production, (Love, Davis, Bassett, Gunther, Nachman 2010).

As stated earlier, the inclusion of sub-therapeutic doses of antimicrobial agents or antimicrobial growth promoters, in animal feed is credited for having contributed to lower costs of meat, milk, and eggs. Antimicrobial growth promoters are fed to cattle to improve feed utilization (Pritchard, et al 1993) and the efficiency of meat and milk production through alterations in rumen microbial fermentation and metabolism, (Alexander, et al 2008). The primary aim is to convert food into lean muscle mass with great efficiency and with the smallest increase in fatty tissue deposits. This is all to be maintained with optimal animal welfare. The growth promoter may improve one more combinations of growth rate, milk production, food conversion and potentially the quality of the carcass (lean tissue and less fat).

However, the practice of growth promoter usage is often associated with the acquisition of resistant enteric flora by the involved animals, a phenomenon that in turn may contribute to the human reservoir of coliforms and salmonellae resistant to antimicrobial agents, (DuPont & Steele, 1987).

Food producing animals are defined as those that provide the human population as well as the large pet food industry with meat, milk and eggs. The food industry in the United States has worked diligently to ensure the delivery of safe, healthy and consumable products for the population. Purchasing food animal products with the possibility of causing harm is unlikely a conscious decision by most food animal producers or Americans.

Certain antibiotics and other medications are prohibited by the Food and Drug Administration from use in food producing animals in order to reduce harm to the general public. These medications include:

(1) Chloramphenicol;

(2) Clenbuterol;

(3) Diethylstilbestrol (DES);

(4) Dimetridazole;

(5) Ipronidazole;

(6) Other nitroimidazoles;

(7) Furazolidone, Nitrofurazone, other nitrofurans;

(8) Sulfonamide drugs in lactating dairy cattle (except approved use of sulfadimethoxine, sulfabromomethazine, and sulfaethoxypyridazine)

(9) Fluoroquinolones

(10)Glycopeptides, (US FDA, 2009)

Table 1 illustrates the current antibiotics that are allowed for use in food producing animals. The OIE International Committee met in its 75th General Session (Resolution No. XXVIII) to discuss the use of antimicrobials in veterinary practice. A List of Antimicrobials of Veterinary Importance was devised by the committee members that delineated the critically important antimicrobials in veterinary medicine. The purpose of this list was to complement the identification of antimicrobials also used in human medicine. "The overlap of critical lists for human and veterinary medicine can provide further information, allowing an appropriate balance to be struck between animal health needs and public health considerations," (World Organization for Animal Health, OIE, 2007). The list of antibiotics was placed into three categories based on certain criteria outlined by OIE. The categories are as follows: critically important antimicrobials, highly important antimicrobials and important antimicrobials. Antibiotic resistance is an emerging problem on a worldwide scale and the correlation with the use of antibiotics in food producing animals is a public health concern.

Most cattle in North America receive antimicrobial growth promoters at some point during production (Alexander, et al, 2008). The FDA has approved 685 drugs for medicated feed, with some that are consumed on a free-choice basis, (Love, et al 2010). The FDA also reported in 2009, that 13.1 million kg of antimicrobial drugs were sold or distributed for use in food-producing animals, (FDA 2010). Over 2 million kilograms of antimicrobial growth promoters are administered to cattle in North America each year. Unfortunately, there are few reports on the effects of feeding antimicrobial growth promoters on the development of antibiotic resistance during beef cattle production (Mathew, et al, 2007). The fact that antimicrobial growth promoters are administered continuously at low concentrations has been hypothesized to increase the risk of the development of resistance compared to antibiotics that are administered therapeutically (Khachatourians, 1998). Non-resistant bacteria tend to grow faster in a population compared to resistant types and will naturally predominate. But when low doses of antibiotics are added it will promote the development of resistance by killing off the non-resistant types. When treating animals and humans it is necessary to have high doses of the antibiotic from the beginning to discourage selection for the resistant type.

Historical data demonstrate that the intensification of food-animal production in the United States increased with the finding that antibiotics used in one form or another increased productivity by decreasing the incidence and severity of disease (Hays 1986; Cromwell 1991).

Figure 4 illustrates the mechanism by which antibiotic resistance develops by under-administration and intermittent dosing of antibiotics. Overdosing of antibiotics can lead to high plasma levels or high levels within the tissues which could be potentially toxic. Under dosing and intermittent dosing allow for antibiotic levels to never achieve the minimum inhibitory concentration (MIC) due to fluctuating antibacterial levels that dip below the MIC dose, (Love, Davis, Bassett, Gunther, Nachman, 2011).

In the past, there were few studies that document the link between antibiotic use in farm animals, the development of antibiotic resistance, and disease transference to humans. However, the reporting of such data is increasing with the development of larger and more accessible databases, refined culture and detection methods, and the overall heightened awareness and concern for this potential source of disease, (Committee on Drug Use in Food Animals, Panel on Animal Health, Food Safety, and Public Health, National Research Council, 1999). There is strong evidence that antibiotic-resistant bacteria can be transferred from livestock to humans (Barton, 2000). Humans are exposed to antibiotic-resistant bacteria through many pathways, including direct animal contact (Price, Graham, Lackey, Roess, Vailes, Silbergeld, 2007), contact with environmental media, such as soil, water and air, contaminated with animal waste (Graham, Evans, Price, Silbergeld, 2009) and consumption or handling of contaminated food products form animals raised with antibiotics (Johnson, McCabe, White, Johnston, Kuskowski, McDermott, 2009).Concern for human health, as well as consumer and political pressure, prompted the European Union to ban antibiotic growth promoters in 1999, (Casewell, Friis, Marco, McMullin, Phillips, 2003).

In one study conducted with beef cattle in Canada, *E.coli* isolates cultured on antibiotic-supplemented MAC agar were more numerous when antibiotics were added to the grain-based diet than when they were added to the silage based diet. High levels of grain in the diets for cattle reduce colonic pH and increases acid tolerance in *E. coli* populations, (Russell, et al 2000). The transition of cattle from a forage-based diet to a grain-based diet increased the population of *E. coli* as much as 1 to 3 (Alexander, et al, 2008). Hence, diet is an important factor to consider in analyzing antimicrobial-resistant bacteria from cattle, especially when phenotypes are compared, given that it may also skew data used for source tracking, (Alexander, et al 2008).

Escherichia coli readily exchanges genetic material with other bacterial species (Davison, 1999) and it is possible that this organism may pass antibiotic resistance genes to transient bacterial pathogens that cause disease in humans (Hummel, et al 1986). *E. coli* possess pili or finger like extensions which enable cells to adhere to each other. Mediated by this, plasmids which are small circular extrachromasomal loops of DNA may be transferred from one cell to another. When a donor bacterium transfers a plasmid, it becomes ‘male’ or the R factor (resistance factor); it then transfers to the recipient ‘female’. Plasmids are important as they carry drug and antibiotic resistance. They can rapidly spread through the bacterial population, converting recipients to donors. *E. coli* is a logical indicator of the extent of antibiotic resistance within microbial populations of the bovine digestive tract, (Alexander, et al, 2008).

Another study measuring the antimicrobial susceptibility in a population of *E.coli* from feedlot cattle administered ceftiofur crystalline-free acid, provided selection pressure that favored transient expansion of multiple-resistant variants, (Lowrance, et al, 2007).

One of the strongest examples illustrating antibacterial resistance comes from the use of avoparcin, an antibiotic analog to vancomycin. Vancomycin and its relative medications have never been approved for use in animals (McDonald, et al 1997) and its main use is in human hospitals. The use of vancomycin has greatly increased in the past 15 years (Ena, et al, 1993; (Swartz, 1994), due to a variety of factors such as an increased incidence of MRSA, prosthetic device related infections, *Clostridium difficile* colitis, and inappropriate use of the drug, (McDonald, et al 1997).

In Europe, avoparcin was used in poultry before it was banned. During this time, vancomycin resistant enterococci were found in poultry raised in Europe but not in US poultry. Since the ban of avoparcin in Europe, the incidence of vancomycin resistant enterococci in humans has decreased (Klare et al., 1999; Pantoski et al, 1999). This suggests that there was a strong correlation between the use of avoparcin for agricultural use and the rise in vancomycin resistant enterococci.

Agricultural antibiotic use for animal growth promotion or for treatment or control of animal diseases generates reservoirs of antibiotic-resistant bacteria that contaminate animal food products (Smith et al 2002). Antibiotic resistant bacteria have been found in farm animals where antibiotics are used heavily, in associated food products and in environments contaminated by animal waste. A study conducted in Denmark showed the amount of manure from animal slurry or feces that contain antibiotics or metabolites of these medications persisted in the environment further promoting resistance, (Sengeløv et al, 2002).

According to a study conducted by the Food and Drug Administration (FDA) in 1999, some 80% of the antibiotics sold in the U.S. are used in farm animals, not in human beings, and 90% of that amount is dispensed through feed or water. Monitoring programs, prudent use guidelines, and educational campaigns can provide approaches to minimize the further development of antimicrobial resistance, (McEwen et al 2002). A thorough and comprehensive account of the amount of antibiotics used in the United States can and will assist in the monitoring of antibiotic use. This would be similar to the plan implemented by Denmark which will be discussed later. Table 3 shows the amount of antibiotics that were made for distribution domestically and those that were exported.

Herd health management is paramount to maintaining healthy livestock. Clean surroundings, ventilation and proper nutrition are some simple means to maintaining healthy, free of disease animals. This may seem to the lay person a standard that is already practiced and should be the norm, but in reality there are many facilities that house animals in filthy conditions, with poor ventilation, dirty water and poor food sources.

Intensification of animal production increases the chances of the spread of infectious agents. Pathogenic micro-organisms are transferred through a number of methods. Transmission can be through animal to animal direct contact via mouth to mouth, feces to mouth, mouth to teat to mouth, and through large droplets in the form of coughing and sneezing or airborne diffusion in aerosols particles which can range in size from 1 nanometer to 100 micrometers, and water droplets/dust. Humidity should be maintained at approximately 75% in enclosed housing areas to ensure adequate air hygiene. In addition to respiratory and gastrointestinal diseases, poor housing will also affect fertility, mastitis and lameness conditions and will markedly affect profitability of the production unit. Providing good ventilation and good drainage ensures adequate humidity for the animals and aids in reducing the infectious agents within the enclosed environment.

Antimicrobial growth promoters are most effective in animals under the stress of inadequate nutrition and suboptimal sanitation (Braude, et al, 1953). That means the incentive to use these compounds decreases as management practices improve. For example, pork producers who wash hog houses every time a group of pigs is moved and who move piglets to off-site growing facilities can reduce their reliance on antibiotics (Dial, et al, 1992).

Thus, producers who practice good management would not be as greatly affected by a ban as producers who do not. This raises the interesting possibility that a ban on growth promoter drug use would actually result in an economic incentive to improve animal care and could result in a more efficient industry in the long term. Denmark, the country used as the prime example of success since the ban on growth promoters, has demonstrated that the economic impact was not negatively affected. In a study conducted by Aarestrup, et al, it was determined that the ban on growth promoters reduced overall antibiotic use and did not significantly impact production. Within the swine industry, the Danish numbers show that the production of pigs increased roughly by 50% between 1992 and 2008, (Aarestrup, Jensen, Emborg, Jacobsen, Wegener, 2010). Figure 3 illustrates the decline of growth promoter usage between 1990-2009 and the increase in swine production between 2004-2009.

The need for antibiotic use in food animals is unlikely to be obviated totally, and strategies involving the prudent and judicious use of antibiotics can have a positive influence on the animal industries. The history of prior antibiotic use is incomplete for food producing animals, and the nature of the samples analyzed make it impossible to track the course of antibiotic resistance in a single animal over time (Alexander, et al, 2008). When disease does occur, the duration and severity of illness can be reduced and perhaps more readily managed by selective and appropriate use of antibiotics. The hope is that the safety of the food supply will be improved by reducing the adverse consequences of antibiotic overuse, while maintaining high standards of animal welfare, production, and food quality, (Committee on Drug Use in Food Animals, Panel on Animal Health, Food Safety, and Public Health, National Research Council, 1999).

Management practices that have implications for reducing the need for drug use focus on manipulating the animal's environment to reduce stress, introducing hygienic measures to reduce exposure to disease, and developing methods to enhance immunity, (Committee Committee on Drug Use in Food Animals, Panel on Animal Health, Food Safety, and Public Health, National Research Council, 1999).

If a veterinarian and the client can agree that herd health management will provide financial gain in the end, then a large part of the problem with antibiotic use has been alleviated. Proper communication is necessary for the veterinarian – client relationship to succeed.

Summary of current problem and study relevance

The major government organizations such as the USDA, FDA, CDC, WHO and AVMA are involved heavily with this public health issue. There are some differing opinions and interpretations of this problem. The following section discusses the differences and concerns on the use of growth promoters.

On July 14, 2010, Representative Henry A. Waxman addressed the Committee on Energy and Commerce on "Antibiotic resistance and the Use of Antibiotics in Animal Agriculture". A very poignant statement was made by Rep. Waxman, "… we would be shocked if a pediatrician ever ordered antibiotics for an entire nursery school class to keep the children from being infected with strep throat. …that is a standard practice for a barnyard full of pigs, or cows, or chickens."

It is clear from the statement made by Rep. Waxman, that it seems illogical for antibiotics to be used as a preventive measure. He reiterated that there appears to be sufficient scientific evidence and that there should be a consensus among major public health groups and experts worldwide that at this moment in time, the need for reducing the use of antibiotics in animals is overdue.

In the testimony by Dr. John Clifford of the U.S Department of Agriculture, July 14, 2010, he stated that the USDA believes that the use of antibiotics in animal agriculture does lead to some cases of antibacterial resistance among humans and in the animals themselves and it is important that these medically important antibiotics be used judiciously (Clifford, USDA).

The USDA alongside HHS is committed to strengthening collaborations with veterinarians and workers within the animal agriculture community in trying to reduce antibiotic use. The USDA also believes that research should be further expanded to identify alternatives in antimicrobial use. It is important that all the organizations involved within the agricultural industry agree that there should not be such a diverging view of antimicrobial use in food producing animals. The need for research and the development of new therapeutics that will protect and preserve animal health should be acknowledged and respected among all concerned.

The USDA also recognizes that a change in management techniques is necessary in order to reduce infectious agents from affecting large populations within the production units. Not only does this include housing but tools and technologies such as new and more efficacious vaccines as well as diagnostic tests that are more sensitive.

The World Health Organization states that due to the trends of human population growth arising, this has worked to increase the number of infections, the need for antimicrobials and certainly an opportunity for misuse. These trends in the human population include:

- urbanization with its associated overcrowding and poor sanitation, which greatly facilitate the spread of such diseases as typhoid, tuberculosis, respiratory infections, and pneumonia

- pollution, environmental degradation, and changing weather patterns, which can affect the incidence and distribution of infectious diseases, especially those, such as malaria, that are spread by insects and other vectors
- demographic changes, which have resulted in a growing proportion of elderly people needing hospital-based interventions and thus at risk of exposure to highly resistant pathogens found in hospital settings
- the AIDS epidemic, which has greatly enlarged the population of immunocompromised patients at risk of numerous infections, many of which were previously rare
- the resurgence of malaria and tuberculosis, which are now responsible for many millions of infections each year
- the enormous growth of global trade and travel which have increased the speed and facility with which both infectious diseases and resistant microorganisms can spread between continents (WHO, 2011).

Due to the growing world population, the need for animal protein to sustain populations has also increased. WHO states that the agricultural practices, that have been ongoing for the past 50 years, have contributed to the increase in resistant microbes and transmission from animals to man from the overuse of antimicrobials, (WHO, 2011).

The World Health Organization also claims that underuse, inadequate dosing, poor adherence and substandard antimicrobials play an important role in resistance. Improving the use of these medications is a priority if the emergence and spread of resistance are to be controlled. In a document entitled *Antibiotic resistance: synthesis of recommendations by expert policy groups* in 2001, produced for the WHO and the Alliance for the Prudent use of Antibiotics, paper claims that the use of antimicrobials as growth promoters facilitates the intensification of food animal agriculture that is characteristic of many industrialized and developing countries allowing for an abundant quantity of food and thereby enhancing the spread of resistant bacteria amongst animals and humans.

There are many antimicrobials that can be purchased without a prescription in many countries and this is also true within the United States. The notion that financial incentives exist with the distribution of antimicrobials seems unethical but the sale of antibiotics appear to be as much as 40% of a veterinarian's income (WHO, 2001).

The CDC plays an important role in educating, monitoring through surveillance and recommending appropriate solutions to preventing antibiotic resistance. They developed the National Antimicrobial Resistance Monitoring System (NARMS) for enteric bacteria and established an educational program called "Get Smart: Know When Antibiotics Work on the Farm".

The purpose of NARMS is to:

1. monitor trends in the prevalence of antibiotic resistance among bacteria isolated from humans, retail meats and food animals
2. disseminating public health information on antibiotic resistance
3. promoting interventions that reduce resistance among enteric bacteria
4. informing the approval process for the use of antibiotic agents in veterinary medicine (Khan testimony, 2010)

The "Get Smart" campaign works to promote appropriate antibiotic use within veterinary medicine and the agricultural industry. In addition, it enforces the need to provide early education to veterinary students. Dr. Tom Chiller, associate director for epidemiological science in the CDC's Division of Foodborne, Waterborne and Environmental Diseases stated that veterinary schools were interested in the campaign because they were seeing a lack of effort in educating the veterinary community on the judicious use of these antibiotics, (Infectious Disease News, 2010).

As Dr. Ali Khan stated in his testimony to the Subcommittee on Health, "the use of antimicrobials should be limited to protecting human and animal health. Purposes other than the protection of animal or human health should not be considered judicious use," (Testimony before the Subcommittee on Health Committee on Energy and Commerce, US House of Representatives, 2010).

In June 2010, the FDA acknowledged that there have been efforts made to address various veterinary and animal producer organizations to institute guidelines for the judicious use of antimicrobial drugs. But they also believe that there needs to be supplementary steps in conjunction with judicious use. Bernadette Dunham, DVM, PhD, and the director of the FDA's Center for Veterinary Medicine stated that "using medically important antimicrobial drugs as judiciously as possible is key to minimizing resistance development and preserving the effectiveness of these drugs as therapies for humans and animals." The new draft of guidelines for judicious use recommends phasing in a measure to limit medically important antimicrobial drugs to uses in food producing animals that are considered necessary for assuring animal health and that include veterinary oversight or consultation, (FDA[1], 2010). The use of antibiotics should be limited to protecting human and animal health.

In a more recent conference, Dr Beth Karp a veterinarian representing the FDA cited that foodborne disease and antimicrobial resistance are global problems. With the increase in international travel, including people, food and animals moving around the world, the potential for spread of resistant bacteria increases as well. She stated that international activities are critical in controlling the spread, (FDA[2], 2010).

The American Veterinary Medical Association (AVMA) recognizes there has been an increased concern over the use of antimicrobials in food producing animals but do not feel there use in sub-therapeutic doses should be eliminated. They subsequently established the Antimicrobial Use Task Force whereby the use of antimicrobials would be evaluated and the critical role veterinarians are placed in would be clarified. With the discussions that had been formulated from the Task Force, AVMA was more accepting of the view that veterinary use of antimicrobials could lead to the development and transmission of antimicrobial use.

The realization that resistance can be transferred prompted the AVMA to create a policy entitled “Judicious Therapeutic Use of Antimicrobials”. The Food and Drug Administration regulates the classification of antimicrobials in veterinary medicine as either over the counter, prescription or veterinary feed directive (VFD), (AVMA, 2009).

The vast majority of feed-grade antimicrobials and some veterinary drugs, are available without veterinary prescription or as a VFD (veterinary feed directives) and are labeled over the counter (OTC). There are some antimicrobials strictly labeled for therapeutic uses, such as treatment, control and prevention, (AVMA, 2009). Other antimicrobials are used as growth promoters and are designed to improve feed efficiency. Prescription antimicrobials are strictly labeled for treatment, control and prevention only. Any inappropriate use without veterinary direction is considered unlawful. Table 1 outlines antibiotics that are currently allowed for use in food producing animals and legal for use.

In 1996, the Animal Drug Availability Act of 1996 established veterinary feed directives. They are intended for use in or on feed, which is limited by an approved application to use under the professional supervision of a licensed veterinarian, (AVMA, 2009). The veterinary feed directives regulation states that the veterinarian must operate within the confines of a valid veterinarian-client-patient relationship, examining and diagnosing animal conditions and determining whether a condition warrants the use of a veterinary feed directive drug.

It appears that the FDA contradicts the very meaning of a client relationship when many over the counter antimicrobials are used as veterinary feed directives. There is no proper way to regulate or monitor the use and amount of antimicrobials in these animals. The Center for Veterinary Medicine of the FDA has stated that since veterinarians are professionally educated, trained and licensed, they should have greater oversight in the use of important antimicrobials, (FDA[2], 2010)

All clinicians that prescribe antimicrobials should have greater oversight, but human nature does not allow for this. No individual is perfect and to expect that a veterinarian or human medical physician will practice prudent and judicious use 100% of the time would be very difficult.

The AVMA Executive Board has proposed two resolutions, 2-2010 and 3-2010, to the House of Delegates that outline what they define the role the veterinarian plays in the debate over antimicrobial use in food producing animals. Resolution 2-2010 recommends that veterinarians be "involved in the decision-making process for the use of antimicrobials regardless of the distribution channel through which the antimicrobial was obtained." Resolution

3-2010, states that AVMA should be at the forefront of discussions about antimicrobial drug availability, specifically regarding regulatory changes. (AVMA, 2009). These resolutions were created after the findings of the AVMA Antimicrobial Use Task Force.

Denmark abolished the use of antibiotics as growth promoters in 1996 in order to reduce the selective pressures promoting antibiotic resistance and due to the concern that there may not be available antibiotics to deal with certain life threatening infections in humans. Denmark fully accepts the scientific evidence that the use of antibiotics in food producing animals selects for resistant bacteria.

The initiatives set forth by the Danish government allowed for a successful transition from non-therapeutic use to the actual abolishing of their use as growth promoters. At the meeting organized by the Subcommittee on Health, Dr. Per Henriksen, the Head of Division for Chemical Food Safety, The Danish Veterinary and Food Administration delineated the initiatives to members of the Subcommittee. The initiatives are as follows:

- there will be no prophylactic use of antimicrobials
- veterinarians will profit very little from the sales of medications
- fluoroquinolones can only be used if laboratory tests show resistance to other antibiotics
- treatment protocol guidelines have been established for swine and cattle veterinary practices
- each veterinarian must be educated on risk management and communication on prudent and reduced usage of antibiotics

- there is continuous monitoring, surveillance and research in antimicrobial resistance in animals, humans and food
- monitoring of food borne pathogens not just in Danish meat but imported meat as well
- swine herds will receive a 'yellow card' if their antibiotic usage is above threshold, (Ministry of foreign Affairs of Denmark, January 2011

The 'yellow card' initiative singles out farms that have used excessive amounts of antibiotics and the government then issues a mandate requiring a reduction. The Danish government also has the ability to identify every herd, farmer and veterinarian. This permits officials to identify the antimicrobial usage down to the individual cow and to an age group of swine, (Schuff, 2010). Farms will be categorized as 'good farming practice', 'satisfactory farming practice' and 'unsatisfactory farming practice'. These categories are based on the amount of antibiotic usage and the level of mortality within each farm, (Meat Trade News Daily, 2010).

Figure 1 illustrates the amount of antibiotic usage for growth promotion and therapeutic purposes between 1990 - 2009. It shows there were a significant decline in growth promoter usage and a concomitant increase in pig production between 2004 - 2009. Since the ban, Denmark's usage of antibiotics has decreased by 40% and with the following positive results:

- the percentage of macrolide resistance in porcine Campylobacter spp. decreased from 80% before the ban to less than 20% in 2006
- 75% vancomycin resistance in enterococci isolated from broilers before the ban to less than 5% in 2006

The increase in medical risks associated with antibiotic resistance in commensal bacteria caused by agricultural antibiotic use is difficult to prove because infection may be an indirect consequence of exposure. The skeptics use this excuse for claiming there is insufficient evidence supporting the transfer of resistant bacteria from animals to humans.

For the groups of people and the AVMA that do not believe there is sufficient evidence to make non-therapeutic antibiotics culpable in the development of resistance, a study conducted by Smith, et al 2002, developed a mathematical model that agricultural antibiotics hastens the appearance of antibiotic resistant bacteria in humans and that the greatest impact occurs very early in the emergence of resistance, when antibiotic resistant bacteria are rare. This type of quantitative evidence can be utilized supporting public policy decisions that will be beneficial to both human and animal health.

One of the most convincing reports involved an analysis of the effects of the growth promoter nourseothricin in the former East Germany. Farmers used this antibiotic in pig feed from 1983 to 1990, replacing the similar use of oxytetracycline. *Enterobacteriaceae* isolated from both humans and animals in 1983 showed little resistance to nourseothricin, but by 1985 transposon-encoded resistant *E. coli* were isolated from pigs and meat products. By 1990, the resistant bacteria had also spread to the farmers, their families, and people living in surrounding areas, (Witte, 1998).

Another case study in 1983 involved an outbreak of salmonella poisoning from humans that consumed raw milk contaminated with multi-resistant *Salmonella typhimurium*. It was found that the individuals affected and the raw milk from a particular dairy, were resistant to several antibiotics that included streptomycin, sulfonamide, chloramphenicol, kanamycin sulfate and tetracycline. The multi-drug resistance in the salmonella isolates was traced back to the raw milk that the affected individuals had ingested (Tacket, et al, 1985).

The United States can learn from the experiences and evidence available from Europe due to the relatively recent ban on the food additive avoparcin for livestock. The use of avoparcin, a growth promoter closely related to vancomycin, was heavily used prior to 1995 within many European countries. The use of avoparcin was accompanied by a significant increase in the incidence vancomycin-resistance among humans. Denmark's response to this public health issue was to ban the use of avoparcin as a food additive in 1995 with Germany shortly following after in 1996, and the European Union in 1997 (Wegener, 1999).

The most recent evidence of transmission into the food supply was through the results of a pilot study conducted by the Food and Drug Administration. The study was looking for Methicillin Resistant *Staphylococcus aureus* or MRSA in ground beef, ground turkey, chicken breast and pork chops. Samples of meat were taken from nine states; 311 staph samples were cultured and 10% of the samples grew MRSA, (Davis, Mukherjee, Davis, Ayers, Young, Tong, Womack, Zhao, Mcdermott, 2011).

A scientific team from Korea also reported MRSA in samples of pork, beef, chicken and sashimi with 89 of them resistant to at least one antibiotic family and eight resistant to at least three antibiotic classes, (McKenna, 2011).

The magnitude of MRSA infections is of deep concern. In 2003-2004, approximately 29% (78.9 million persons) and 1.5% (4.1 million persons) of the U.S. population was colonized in the nose with *Staphylococcus aureus* and MRSA respectively, (Gorwitz, et al 2008). An estimated 478,000 hospitalizations were diagnosed with *Staphylococcus aureus* infection in U.S.

hospitals back in 2005. Of these 478,000 hospitalizations, approximately 278,000 people were infected with MRSA. This includes people admitted to the hospital for treatment of an infection that was acquired or occurred outside the hospital, (Klein, Smith, Laxminarayan, 2007). Figure 2 shows the marked increase incidence of resistant bacteria from 1980-2005.

This evidence creates a strong case for policy decisions. Many drugs are used in humans and animals and it can be difficult to trace the exact spread of resistance in bacteria found in animals and those found in humans. Attempts at changing the practices of the agricultural industry have been in action every year since the 108th Congress with little to no improvement(s) in present day methods of rearing food-producing animals.

Ironically, the American Veterinary Medical Association is against two of the most prominent bills that would provide legislation ensuring the safety of the animals and the public health of the general population. The mission statement of the AVMA claims its intent is to improve animal and human health and advance the veterinary medical profession. The objective is to advance the science and art of veterinary medicine, including its relationship to public health, biological science and agriculture, but there position on these important legislations is one of non-support, (AVMA, 2011). There are many non-veterinary related organizations that are in favor of the proposed legislation and recognize that there is a problem with the current agricultural practices the United States employs.

One of the main arguments against a ban is that it would cause economic hardship for livestock and poultry producers and raise costs for consumers. “The economic impact of a US ban largely would depend on the willingness of US veterinarians to increase therapeutic use,” (Hayes and Jensen, 2003). In large part, sub-therapeutic feeding of antibiotic drugs is a management tool to prevent infection and to facilitate the use of confinement housing. This practice allows larger numbers of animals to be maintained in a healthy state and at a lower cost per unit to the farmer.

The AVMA argues that if there is greater veterinary stewardship of antimicrobial access, this could potentially affect some small producers that are able to purchase and treat their own animals with older over the counter antimicrobials should a veterinarian not be accessible. This could subsequently affect smaller producers and force them to shut down. Also, if sub-therapeutic use of antibiotic agents were eliminated, these production advantages would be reduced or lost and consumers would pay more, (Committee on Drug Use in Food Animals, Panel on Animal Health, Food Safety, and Public Health, National Research Council, 1999). The costs associated with a ban should be compared with the benefits to consumers (valued as the benefits from reduced health problems). But there are many that would argue about the economic aspect, that reduced costs to the consumer is a primary incentive in the purchase of foods of animal origin and outweighs the health benefits.

There are some groups of individuals that believe that by increasing feed efficiency with growth promoters reduces the need for crops grown for animals feed, lessening the amount of animal waste and reduces the animals' carbon footprint. But, the more consolidated the livestock industry becomes, to maximize production and profits, the more small scale farming industries will be pushed out. Large scale production units will require more land for feed production. More feed requires more fossil fuel-intensive farming, (Pauchauri, 2008).

Globally, thirty-three percent of the world's cereal harvest and ninety percent of the world's soy harvest are now being raised for animal feed, (Pauchauri, 2008). Feed crop farmers are heavily dependent on fossil fuels, used to power the on-farm machinery as well as used in the production of the petroleum-based chemicals to protect against pests, stave off weeds, and foster soil fertility on large-scale monoculture fields. The crops use tremendous amounts of fertilizer and within the United States half of all synthetic fertilizer is used for feed crops, (Steinfeld, 2006). Erosion and the deterioration of soils on industrialized feed farms and intense production units will have an effect on global warming, hence, improving crops and grazing or land management techniques can help to reduce soil carbon emitted and the effects of global warming. Figure 2 displays a flow chart depicting the ecological impact of the use of antibiotics in food animals. The information was obtained from Phillips, et al 2004.

It is important to recognize that the intensification of the livestock industry has had a substantial impact to the environment; water, land and biodiversity of surrounding areas. “In many situations, livestock are a major source of land-based pollution, emitting nutrients and organic matter, pathogens and drug residues into rivers, lakes and coastal seas,” (Food and Agriculture Organization of the United Nations, 2006). It is also important to note that as much as 75% of administered antibiotics (Chee-Sanford, Mackie, Koike, Krapac, Lin, Yannarell, 2009), and considerable amounts of anti-parasitic medications (Lumaret and Errouissi 2002), are not absorbed by animals and are eliminated in their waste; urine and feces. These wastes contribute to drug loads in watersheds and in other environmental media that may become available for human or non-target organism exposure (Arikan, Rice and Codling, 2008; Chee-Sanford, et al 2009; Lumaret and Errouissi 2002).

The demand and production of livestock products are increasing rapidly in developing countries and have outpaced developed countries with poultry having the highest growth rate. This increased demand is associated with structural changes within these countries’ livestock sectors, such as intensification of production, vertical integration, geographic concentration and up-scaling of production units, (Food and Agriculture Organization of the United Nations, 2006).

The AVMA also argues that a ban could decrease animal health and welfare due to overly stringent regulations or cumbersome requirements that may delay delivery of medicated feeds, allowing animal disease to proliferate and suffering to progress. This will have a ripple effect, according to the AVMA, in that a decline in animal health will impact food availability and safety. The added burden of recordkeeping and other logistics will shift the focus from animal care to recordkeeping activities, (AVMA[2], 2009)

Chapter 3—Methodology

Introduction

The evidence necessary to defend the argument over the use of growth promoters is strong but the opinions of veterinary and medical leaders from governmental agencies and the private sector add credibility. It is through these channels and evidence based studies that requests for policy change(s) are taken more seriously.

Governmental discussions within Europe, the current legislation in the European Union and the United States have been discussed within this paper. It was found through analyzing the history of antibiotic use and the emergence and identification of resistant bacteria that the thought processes of veterinarians and government officials in Europe began with concern over antibiotic resistance as early as the 1960's. The European Union has set strict guidelines to the use of additives in the food supply due to the growing concerns and the United States has some contradictory views over what is judicious and what is not judicious use over growth promoter additives.

This chapter will discuss the methods employed to review the current laws and pending legislations within the United States. It is imperative to understand the reasoning behind a bill and what the intended purposes are, in this case to preserve the health of the animal and human population from antibiotic resistant bacteria. Internet access is necessary to connect to the relevant links that are available to the general public.

Research Design

This SSP incorporated a literature review of the problem and addressed the legislative policies within the United States. Policy analysis was utilized as a method of analyzing the current legislation in order to find common themes among the sponsors of the bills. The policies of the present day laws, the areas that are under question and the most recent hearings in Washington D. C. involving testimony from representatives of the CDC, Denmark, AVMA, WHO, FDA were reviewed.

In order to conduct a similar study related to policy analysis and food-producing animals, a computer with internet access is required. Membership to exclusive organizations is not required because the content of current laws and pending legislative actions are open to the general public without restrictions.

Procedures

The first course of action in determining if there has been debate over the use of growth promoters were to identify if there are any laws related to the issue. I needed to determine if there was open discussion among government officials as well as experts and individuals within the agricultural industry. The important question to refer back to was if the open dialogue dealt with the use of antibiotics in food producing animals.

Instruments

In order to determine the current debates over legislation regarding antibiotic use in food producing animals, I initially searched through the American Veterinary Medical Association website. The site has links to many public health issues such as zoonoses, animal welfare, disaster preparedness, veterinary medical ethics and a section dealing with national and state policies. This link is accessible to the general public and the need for obtaining exclusive veterinary membership is not required. Under the heading advocacy, a link for ‘congressional activities’ is available to access. This section allows an individual to view the current federal legislative and regulatory issues that influence animal and human health in the hopes of advancing the veterinary medical profession, (AVMA, 2011).

‘Congressional activities’ allows the researcher to view the most recent activity within the 111th Congress. There are thirteen issues within this link that influence animal and human health. Of the thirteen, pharmaceutical issues provide the most relevant information and current legislation related to antibiotic use in food producing animals. They are the Preservation of Antibiotics for Medical Treatment Act and Strategies to Address Antimicrobial Resistance (STAAR). The link for these proposed legislations is easily accessible and allows the researcher to read the position of the AVMA and why they do or do not support the bill.

Locating the most relevant legislative actions was the first course of action in determining how to implement new policies that would be beneficial to both animal and human health. The next step was to analyze the current policies. They are accessible through a site sponsored by the Library of Congress, THOMAS. “THOMAS was launched in January of 1995, at the inception of the 104th Congress. The leadership of the 104th Congress directed the Library of Congress to make federal legislative information freely available to the public”, (Thomas, 2011).

The search engine available through Thomas was able to provide an outline of PAMTA and STAAR, the two most important pieces of legislation regarding antibiotic usage in food producing animals and the Animal Drug Availability Act of 1996. The key words utilized when searching for these legislative actions were ‘antibiotics and animals’. This brought up a wide array of other pending legislation but PAMTA and STAAR appear to be the only relevant legislation regarding growth promoter usage. These bills were easily identifiable and would not pose a challenge for a researcher to identify.

While conducting the literature review, mention of the SWANN Report from the United Kingdom and Regulation 1831/2003 came up often as references when comparing the policies and decisions made in the United States and Europe. The SWANN Report and Regulation 1831/2003 are straightforwardly found on a computer search engine.

Plans for Data Analysis

The analysis of the present day laws and pending legislation was modeled after six steps devised by Carl V. Patton. He defines policy analysis as a “process through which we identify and evaluate alternative policies or programs that are intended to lessen or resolve social, economic, or physical problems,” (Social Research Methods, 1999). His six steps with relevant examples are as followed:

1. Verify, define, and detail the problem
    - the use of growth promoters in food- producing animals promotes antibacterial resistance
2. Establish evaluation criteria
    - a change in the production units management of food producing animals will benefit both human and animal health
    - economic evaluations are necessary when considering altering the structure of how the agricultural industry functions in the United States

3. Identify alternative policies
    - proper recommendations and alternatives to rearing of food-producing animals are necessary to consider if growth promoter usage is abolished
4. Evaluate alternative policies
    - utilizing the Denmark experience to compare the alternative methods and show the positive influence to the economy, health of humans and animals is necessary in order to change the views of policy makers
    - economic analysis (cost-effective analysis), a decrease in the amount of resistant bacteria found in food and amongst food production workers are necessary for evaluation
5. Display and distinguish among alternative policies
    - economic evaluations from Denmark show positive growth with reduced antibiotic usage
    - Denmark experience is an excellent example of success economically, the increased production of farm animals, reduction of antibiotic usage and the change in animal husbandry is in a positive direction
6. Monitoring the implemented policy
    - monitoring the level of antibiotic resistance through surveillance (NARMS), antibiotic usage and economic growth of agricultural industry are paramount in ensuring the success of stopping the use of growth promoters

Limitations and Delimitations

The study involved analysis of the two most prominent pending legislations and the relevant law currently in place related to food-producing animals. This facilitated the research of this SSP since there were few bills and laws to decipher through. Hopefully, the bill and pending legislation are not a reflection of the lack of concern regarding antibiotic resistance within the agricultural industry.

There were no delimitations to conducting the analysis of present day laws and pending legislation. This study was also approved by Emory's Institutional Review Board.

Theoretical framework

Policy changes on a whole are not influenced by behavioral theories. The law is set and the general population must abide by the new legislative actions. However, the theoretical framework that influences the manner in which the policy change is implemented is of great importance. The approach of governmentality provides a way of analyzing the implementation of a new policy.

Governmentality was first described by Michel Foucault. He stated, "Governing people, in the broad meaning of the word, governing people is not a way to force people to do what the governor wants; it is always a versatile equilibrium, with complementarity and conflicts between techniques which assure coercion and processes through which the self is constructed or modified by himself", (Foucault 1993).

The governmentality approach, analyzes the ways in which policy processes are amplified and executed outside the direct control of government legislation and regulation (Coveney, 2010). Hal Colebatch defines governmentality by means of vertical and horizontal axes of policy activity. The vertical axis represents the activities of the authorized decision makers or the government jurisdictions. The horizontal axis represents the level of activities by stake holders such as professional organization, community groups, commercial interest, all that have a stake in the policy and its outcome.

The horizontal group is key and crucial to the implementation of the policy initiative as it is and to mold the policy to meet their own interests. This group attains authority through their direct experiences and expertise and justifies their involvement with the issue. It gives the idea that the policy is enacted on behalf of the government rather than by the government. The idea of government at a distance is the main premise behind the governmentality approach.

Changing a whole method within the agricultural industry would be very disconcerting to many and a slow phase-in governmentality approach would be the most effective way to ensure success. The perception that there is little government involvement may bode well to those within the industry.

Governmentality is especially useful in understanding the relationships among government, nongovernment and private investments in policy implementation, (Coveney, 2010). Perhaps another way to conceptualize governmentality would be that those affected by the change, primarily the agricultural industry are at the forefront of implementing and advocating change for the betterment of their business and for the animals. The agricultural industry would conduct and evaluate themselves into alignment with political objectives- reducing antibiotic usage as growth promoters and altering animal husbandry methods for the betterment of the animals and the public health of the human population.

But the key to successful policy design and implementation relies on ensuring the right mix and sequencing of different policy measures. Typically, the literature will distinguish between two broad approaches for implementing policies: regulatory approaches and economic instruments. It’s important to find and successfully implement a mix of the right strategies, regulations and/or other interventions to achieve the desired policy outcomes or to address an important issue.

Chapter 4—Results

Introduction

This chapter discusses the results of the legislative review. It is important to incorporate the SWANN report from the United Kingdom as it has some very insightful and poignant messages, (Swann, 1969). Members of the House of Lords in the United Kingdom, were cognizant there was something inherently wrong with the practice of growth promoters in the food supply and it is unfortunate that here in the United States it has taken almost 50 years to have a similar debate on the topic. As the US society maintains deep involvement with a myriad of political issues, food safety should be at the forefront of concern. The United States is providing protein sources for a national population of approximately 350 million people and provides to the global population as well. Antibacterial resistance is an emerging global problem.

The following section discusses some of the early dialogue within the United Kingdom, the European Union's Regulation on feed additives and the current pending legislation within the United States. The most recent legislation within the United States include H.R. 2508 "Animal Drug Availability Act (ADAA) 1996", H.R. 1549 "Preservation of Antibiotics for medical Treatment Act" and H.R. 2400 "Strategies to Address Antimicrobial Resistance (STAAR) Act".

Findings on Legislative Action

When applying food safety laws, government agencies at the federal, state and local level are responsible for implementing action. The agencies are broken down into two groups: (1) public health non-regulatory agencies and (2) food-safety regulatory agencies. The public health agencies are responsible for disease surveillance and investigation of food-borne outbreaks, individual illnesses and the scientific research associated with food-borne illnesses. The regulatory agencies issue and enforce food safety requirements and are responsible for the public’s safety and health. (Kux, Sobel, Fain, 2007). It is the hope of a policy change that the appropriate measures will be followed through accordingly in order to provide a smooth transition for farm production units and in reducing unnecessary stress to the animals.

SWANN report from the United Kingdom

In 1969, at the House of Lords in the United Kingdom, a representative, Mr. Cledwyn Hughes, from the Ministry of Agriculture, Fisheries and Food, presently known as DEFRA, reported to the House on antibiotic use within the agricultural industry and the ramifications this may have amongst the population not only within the UK but globally. He stated that “The Committee found that the administration of antibiotics to farm livestock poses certain hazards to human and animal health since it has led to the emergence of strains of bacteria which are resistant to antibiotics. The committee was satisfied that these hazards can largely be avoided and has put forward a number of recommendations to that end. ..., the committee recommends that the use of penicillin and the tetracyclines in feedingstuffs should be prohibited; and that certain other drugs which are now freely available should also be available only on prescription”.

These statements were made in 1969 before the scientific evidence, that we have today, was available. Unfortunately, it has taken almost 50 years later for policies within the United States to be examined and scrutinized for the betterment of public health for humans and animals.

As one member of the House of Lords stated, “..., consider the continuing anxiety that when new therapeutic substances come on the market something has to get out of control before anything is done?” This wise statement can be applied to the use of antibiotics in the United

States. The policies need to be revised sooner rather than later. We have great knowledge of the biochemistry and genetic capabilities of bacteria in the area of resistance and this understanding will help to create decision making policies that will benefit public health.

Regulation No 1831/2003 of the European Parliament and of the Council

The main purpose of this Regulation, within Europe, is to establish a community procedure for authorizing the use of feed additives and to lay down rules for the supervision and labelling of feed additives and pre-mixtures in order to provide the basis for assurance of a high level of protection of human health, animal health and welfare, environment and users' and consumers' interests in relation to feed additives while ensuring the effective functioning of the internal market. No person or company shall market, process or use a feed additive unless it has been approved and granted in accordance with the Regulation. There are strict rules to adhere to by the manufacturer in order to protect the health of the public and animal population, (Official Journal of the European Union, 2003).

This Regulation ensures that indiscriminate use of antibiotics as growth promoters hidden in feed can be curtailed. It is an important role of the European Union to protect the people of its member countries. The United States can use this Regulation as an example of controlling the manufacturers of feed for food producing animals in order to prevent illegal and/or unnecessary use of antibiotics without a prescription. The possibility of underhanded operations that supply antibiotics to feed operations that will supplement the diets without supervision is a real concern and an issue that has received legal action in Europe. Back in 1999, the United Kingdom was investigating thirty-nine cases of unauthorized use of antibiotics and other medicines. They were being sold at a quarter or third of the veterinary price in the UK, (Meikle, 1999).

Animal Drug Availability Act (ADAA) 1996

This law was passed into legislation to facilitate the use and accessibility of antibiotics for animals without compromising the mission to promote and protect the public's health. It was stated on the floor that it had become increasingly cumbersome, unpredictable, prolonged and complicated on approving drugs for animals. The bill implements two items from the National Performance Review now recognized as the National Partnership for Reinventing Government, where it would allow FDA to set tolerances for drugs used on farm animals whose meat ultimately is imported into the United States and permits FDA to set import tolerances for drugs used in other countries, (Dupont, 2002).

"Minor species, are by regulatory definition, any species other than dogs, cats, horses, cattle, swine, chickens and turkeys. Terrestrial minor animals include sheep, goats, game birds, emu, ranched deer, elk, rabbits and cavies (e.g. guinea pigs), earthworms, crickets, frogs, salamanders, snakes, lizards, tortoises, caged birds, free-ranging wildlife and those in zoos and small pet mammals (not dogs and cats). All aquatic animals, including all finfish, aquatic turtles, crustaceans, and mollusks are minor animal species. Minor species include a wide range of animals including those that are kept as household pets, those kept for display and educational purposes in zoos and public aquariums, and those that are raised commercially as food or for recreational fishing," (AVMA, 2011).

Many of these animals, for example fish, sheep, game birds, are used for food as stated in the definition of minor species and to improve the availability of certain antibiotics needs careful consideration. It would be difficult to isolate one individual fish for treatment of an ailment, instead the entire school would have to be treated whether they needed it or not. This is neither judicious nor prudent use of antibiotics. It is important to question whether the conditions these animals are living in perpetuate infectious disease transfer and it should be addressed as a primary issue instead of facilitating the accessibility of antibiotics.

Preservation of Antibiotics for Medical Treatment, (PAMTA)

PAMTA was designed to amend the Federal Food, Drug and Cosmetic Act in order to preserve the effectiveness of medically important antibiotics used in the treatment of human and animals' diseases. It was first introduced into congress and the senate at the 108th Congress without further approval. The bill has been discussed for five consecutive years by the committee. After the bill is introduced to the committee, members will deliberate and investigate further before going to general debate. PAMTA has been unsuccessful in passing to general debate in the hopes of becoming a law. In 2009, H.R. 1549 was overwhelmingly supported by democrats and opposed by republicans, (Open Congress, 2009). The most recent attempt at re-introducing the bill, H.R. 965, was on March 9th of 2011 by Louise Slaughter (D-NY). Congresswoman Slaughter has a degree in microbiology and a Master's in Public Health; with this in mind, her passion for approval of PAMTA is evident in her multiple attempts for support. She firmly believes that antibiotic usage in the agricultural industry requires revision and the public health issue of antibiotic resistance requires urgent attention.

The main points that congress revealed include:

- *In 2001 it was stated that any overuse or misuse of antibiotics contributes to the spread of antibiotic resistance, whether in human medicine or in agriculture*
- *Antibiotic resistance, … may impair the ability of the United States to respond to terrorist attacks involving bacterial infections or a large influx of hospitalized patients*
- *The National Academy of Sciences states in March 2003:*

    - *a decrease in antimicrobial use in human medicine alone will have little effect on the current situation*
    - *substantial efforts must be made to decrease inappropriate overuse in animals and agriculture*
- *An estimated 70% of the antibiotics and other antimicrobial drugs used in the United States are fed to farm animals… for:*
    - *growth promotion*
    - *compensation for crowded unsanitary conditions, stressful farming and transportation conditions*
- *A periodical entitled "Clinical Infectious Diseases" published a report in June 2002- recommending that antimicrobial agents should no longer be used in agriculture in the absence of disease but limited to therapy for diseased individuals' animals and prophylaxis when disease is documented in a herd or flock.*
- *In April 2004, it was concluded by the General Accounting Office that Federal agencies do not collect critical data on antibiotic use in animals and that they need to support research on human health risks.*

The AVMA opposes PAMTA because eliminating antibiotics as growth promoters would result in increasing animal disease and death without assurance of improving human health. PAMTA seeks to remove growth promotion and feed efficiency uses, but will also prohibit prevention and potentially control uses in feed or water. The AVMA argues that a ban under the legislation would be contrary to the practice of veterinary medicine and is not based upon actual risks, (AVMA, 2009). Although the AVMA states there is insufficient scientific evidence, the studies cited in this paper have demonstrated the link between antimicrobial use and resistance development in enteric bacteria amongst the animals themselves as well as the farm workers and consumers that have been exposed.

Animal Drug User Fee Amendment of 2008

This is an amendment to the Federal Food, Drug and Cosmetic Act requiring applications from sponsors for new animal drugs containing antimicrobial agents. These sponsors must submit an annual report to the FDA on the amount of each ingredient in the drug if it is sold or distributed for use in food producing animals. The purpose of this amendment is to assist the FDA in its continuing analysis of interactions such as resistance, efficacy and the safety of antibiotics approved for use in both humans and food producing animals. Table 4 is an annual summary from 2009 of the total amount of all approved antimicrobial agents in all its forms (injectable, oral, medicated feed) that were sold both domestically and exported to other countries.

Under the FDA, the Federal Food, Drug and Cosmetic Act (21 U.S.C) required that all drugs are shown to be safe before the drug(s) is approved. This places the burden on manufacturers to account for health consequences and proven safety. The FDA modified this drug approval process to recognize the development of resistance to certain antibiotics as an important aspect of safety. The problem with this amendment is that the FDA has not established a schedule for reviewing antibiotics that were previously approved. Hence, the level or measure of antibiotics that have promoted resistance and been in use for some time may not be examined or further studied.

Strategies to Address Antimicrobial Resistance, (STAAR)

The STAAR Act seeks to amend the Public Health Service Act to enhance efforts to address antimicrobial resistance. Enactment of this bill would establish an Antimicrobial Resistance Office and a Public Health antimicrobial Advisory Board in the Office of the Secretary of Health and Human Services. The bill also has provisions for the collection of antimicrobial drug data and the establishment of antimicrobial resistance surveillance and research network sites. This bill was introduced in the 110th and 111th Congress and subsequently was not passed by the committee to enter general debate.

The main purposes of this bill are to obtain data on the amount of antimicrobial products used in humans, animals, and plants from reliable sources including data from the Centers for Disease Control and Prevention, the Food and Drug Administration, the Environmental Protection Agency, the Department of Veterans Affairs, the Centers for Medicare & Medicaid Services, the Department of Homeland Security, and the Department of Agriculture, and as feasible from private sources and international bodies; discuss and review the impact of antimicrobial resistance on human health resulting from the approval of antimicrobial drugs for use in humans or animals (including consideration of and recommendations on potential management plans to limit and reduce the negative impacts of such resistance on human health), (GovTrack, 2009).

In a statement made by Congressman Jim Matheson of Utah, he quoted from an article through the Infectious Diseases Society of America "Bad Bug, No Drugs: As Antibiotic Discovery Stagnates a Public Health Crisis Brews", there is a lack of research and development for new antibiotics. He alluded that antibacterial drugs are not profitable. They are usually taken for a short period of time, unlike other medications that treat for chronic conditions are taken daily. Because of the short duration of treatment, Matheson claims that pharmaceutical companies do not have a financial interest in antibiotic development. This is a major problem as resistant bacteria become more prominent with an increase in the number of cases and virulence. It will become increasingly more difficult to treat patients appropriately.

The AVMA does not support approval of this bill. Representatives of the AVMA state that this bill has the potential to politicize the drug approval process, with the potential for biases and political agendas to negatively impact the current drug approval process, (AVMA, 2010). Hence, the reason for resolutions 2-2010 and 3-2010 to be formulated by the AVMA, allow more involvement of veterinarians in the regulatory process.

STARR is endorsed by numerous reputable organizations such as:

- The Infectious Diseases Society of America
- American Academy of Family Physicians
- Alliance for the prudent User of Antibiotics,
- American Association of Critical-Care Nurses
- National Parent-Teacher Association
- American Public Health Association
- National Foundation for Infectious Diseases
- Council for State and Territorial epidemiologists
- American Society of Health-System Pharmacists
- Association for Professionals in Infection Control and Epidemiology
- International society of Microbial Resistance
- Society of Infectious Diseases Pharmacists

- Trust for America’s Health

It would be unfortunate if the views of the AVMA and lobbyists are swaying the decisions made by committee members. Altered opinions by the committee would prevent the bill from entering general debate. Table 3 shows members of the committee that voted in favor and those opposed to consecutive attempts at legislation.

Summary

How much longer will it take for congress and senate to agree and understand the implications involved with growth promoters? A major point to consider is the time needed for congress and the senate to agree on new policy issues that pertain to the agricultural industry and public health. There are many other aspects to consider when implementing policy change such as economics and the attempt to change the views of those within the agricultural industry. The theoretical model utilizing governmentality is helpful in implementing policy change and allows those with the industry to feel as if they are in control of their livelihood and making decisions for the betterment of their field without feeling forced by government regulations.

Chapter 5—Discussion

Introduction

Food safety is becoming more of a concern for the general population as well as for government officials. The general population is becoming more aware of humane issues and wants to know what is entering their food supply that could be potentially harmful. This special studies project has provided the evidence based studies from peer reviewed journals that prove the link with antibiotic usage and the promotion of antibiotic resistance. This paper also delineates the contradicting opinions from veterinarians that do not believe the use of growth promoters is causing or perpetuating any harm to the general public.

As we become more conscious of our food in order to maintain the health of the population, it is imperative that the government listen to the concerns of its people and rely on the evidence provided by experts in order to make sound decisions regarding the rearing of food producing animals.

Summary of study

There is increasing apprehension over the use of antibiotics in food-producing animals as growth promoters. Antimicrobial resistance is a large public health issue and the relationship with food producing animals warrants changes in the current policies of the United States over control on the use of antibiotics. Food producing animals are reared in highly intensive production units that increase the susceptibility of infectious diseases. Efficiency and reduced costs are taking precedence over the potential impact on the health of humans and animals.

The evidence based studies that have been cited in this document have been accepted largely within the scientific community as sufficient to incite discussion and a desire for change in how America rears food-producing animals. Congressional and senate leaders have differing views on what is considered fact and what is considered a hypothesis. Regardless, consideration for the health of a national and international population are being reviewed but should be expedited. The 50+ years of antibiotic use within the agricultural industry have created complacency amongst those within the field and it is my opinion that changes can and ought to be imminent.

Results

Based on the scientific literature, there is an obvious link between the use of antibiotics and the development of resistance. The studies cited in this paper illustrate the scientific evidence of gene resistance transfer among bacteria and working people in the agricultural industry that had contracted resistant enteric bacteria. The evidence out of Denmark showing the marked improvement in animal husbandry methods, the reduced use of antibiotics and reduced number of resistant bacteria in the food producing animals should be commended. It is in my opinion that the FDA should rectify and make appropriate changes within the legislation to ban the unnecessary use of growth promoters. It cannot be stressed more that prudent use of antimicrobials is at the hand of the veterinarian within the agricultural industry.

The use of antibiotics for non-therapeutic purposes or as a growth promoter goes against the principles of the judicious use of antibiotics. Animals are reared in a hyper-efficient manner in order to increase profits. This method of practice will further promote inhumane practices and enhance the idea that growth promoters are a ‘good thing’. Critics of the traditional way of raising livestock compared to industrial-scale confinement operations may claim it is in the name of “efficiency”.

The European agricultural industry should be used as an example of success and the sustainable farms such as Applegate Farms and the Niman Ranch should be used also as successful examples here in the United States.

Implications

Very often the uses of antibiotics are administered to validate a diagnosis and according to (Current Veterinary Therapy, 1990), the basis for selecting, using and monitoring of antibiotic use is often irrational. Aucoin states that there are three validations to the use of antibiotics, the first being that even though an antibiotic is given to a patient without a known bacterial infection, it is still safe because the toxicity of the antimicrobial is small. This is surely dependent on the antibiotic because there are some that can be very toxic to the animal. The second axiom defines the use of antibiotic as prophylactic since a sick animal with a viral infection may develop a secondary bacterial infection. So, in essence we are preventing an infection from developing. The third axiom Aucoin points out is that the most potent antibiotics should be reserved for the very sick patients or those that did not respond appropriately from the first round of treatment. To conclude on these three ideas, the use of an antibiotic inappropriately will increase the probability of bacterial resistance.

Recommendations

The following alternatives to antimicrobials in food animal production include government regulation, education incorporating judicious or prudent use, research, alternatives to antimicrobials and management practices that will reduce the likelihood and effect of infectious disease and also increase the production efficiency, (McEwen, et al, 2002).

Public health will benefit if agricultural antibiotic use is restricted before antibiotic resistance merges. Multidrug resistance has profound medical consequences and can be managed appropriately by regulating agricultural antibiotic use as well as medical antibiotic use in humans, (Smith, et al 2002).

The scientific literature suggests there are 10 critical controls to manage the use of antibiotics. They are as follows:

1. Practice healthy herd management
2. Establish a valid veterinarian/client/patient relationship
3. Use only approved over-the-counter (OTC) or prescription (Rx) drugs with a veterinarian's guidance
4. Make sure all drugs used have labels that comply with regulatory requirements
5. Store all drugs correctly
6. Administer all drugs properly and identify all treated animals
7. Maintain and use proper treatment records on all treated animals
8. Use drug residue screening tests only on cows treated with extra-label drugs, if appropriate test is available
9. Implement employee/family awareness of proper drug use to avoid marketing adulterated products
10. Complete a Quality Assurance Checklist annually
    (Pfizer, 2008)

Government Regulation

Government regulation is paramount in order to gather a better understanding of the ramifications to society regarding antimicrobial resistance amongst the human and animal population. The United States and many European countries have put into operation surveillance systems in order to monitor resistance in their respective countries. They have different methods of monitoring but the general goal is to safeguard the public health.

As stated earlier, NARMS (National Antimicrobial Resistance Monitoring System) is a national public health surveillance system that tracks antibiotic resistance in foodborne bacteria. The NARMS program was established in 1996 as a partnership between the U.S. Food and Drug Administration (FDA), the Centers for Disease Control and Prevention, and the U.S. Department of Agriculture (FDA, 2010). NARMS monitors antimicrobial susceptibility among enteric bacteria from humans, retail meats, and food animals. NARMS also collaborates with antimicrobial resistance monitoring systems in other countries, to work towards international harmonization of testing and reporting, (FDA, 2010).

Denmark is noted to have two methods of surveillance, VETSTAT and DANMAP. The program designed VETSTAT to monitor antibiotic use on all food animal herds in the country, the species and age, class of animals treated, and reasons for treatment, (Bager, 2000). The importance of a monitoring system such as VETSTAT is that it allows for accurate estimates to be made regarding the amount of antibiotic usage for each species, how they are administered, and the duration of treatment and for what purpose.

DANMAP is a surveillance monitor system that manifests trends in antimicrobial resistance among bacteria from animals, food, and humans. DANMAP also has the ability of modeling the transmission of resistance from animals to humans by surveying the amount of antimicrobial agents used.

France has developed Agence Francaise de Securite Sanitaire Des Aliments, AFFSA, with the intent of utilizing two surveillance methods. One to monitor resistance form nonhuman zoonotic Salmonella and the second collects data from local public veterinary diagnostic laboratories pertaining to bovine pathogenic strains, (McEwen, et al, 2002).

The Spanish government developed Red de Vigilancia de Resistencias Antimicrobialas en Bacterias de Origen Veterinario. This system reports both qualitative and quantitative data of bacteria from sick animals, healthy animals and food animals, (Moreno, et al 2000).

The British have a division within their government called the Department for Environment, Food and Rural Affairs, DEFRA, and they compile antimicrobial resistance and prevalence data in salmonella spp. The data is reported to DEFRA by animal species and feed/feedstuffs, (McEwen, et al, 2002).

It would be beneficial to maintain appropriate records with the industries that produce food for the animals and what additives are being incorporated into the feed. The potential for irresponsible production cannot be ruled out. Regulation No 1831/2003 of the European Parliament and of the Council should be used as a model for the United States for incorporating further safety measures in feed additives. In order to prevent corrupt practices and ensuring the safety of the population, a regulatory policy should be considered a high priority in this country.

A most recent attempt for monitoring antibiotic usage has come out of Ghent University, Ghent, Belgium with Project AB. It gives farmers and their advisors an opportunity to quantify the amount of antibiotic use on their farm. If enrolled in the project, the incidence of treated farm animals (pigs, turkeys and poultry farms) is measured. Advisors can get an insight into the amount of antibiotics used and this can be compared with other farmers in their regional area. The Unit for Veterinary Epidemiology of the Faculty of Veterinary Medicine and Boerenbond and Certus main goals of the project are to guide farmers towards a more responsible use of antibiotics. The intent is to create a plan of action designed to optimize farm management in a way that antibiotics will become less necessary and still achieve good production results. This is an excellent way to incorporate farmers, participation is free of charge and it can create a positive experience for them as well, (Ghent University, 2011).

The website is easily accessible to farmers and clearly wants them to become engaged with the project. It states: “Cooperating farms will be visited on four occasions. The first farm visit will consist of an evaluation of the problems on the farm, the current amount of antibiotics used (based on treatment incidence) and the level of biosecurity on the farm. Based on these data a farm specific action plan will be developed in which, if possible, the focus will be on reduced and more responsible use of antibiotics and optimization of farm management. An in between evaluation will indicate if the implicated measures have the expected impact. In the final evaluation we hope to conclude, together with the farmer and the involved farm advisors, that the amount of antibiotics used is reduced and the overall farm management has improved in the benefit of sustainable pork production. Throughout this guidance process your farm veterinarian will be informed at all times and he/she, together with the other advisors, play an important role in the success of the whole process,” (Ghent University, 2011).

Prudent or Judicious Use

It is the responsibility of the veterinarian to safeguard not only animal health but also the health of the human population. The World Veterinary Association strongly believes that the profession of veterinary medicine should strive to protect both animal and public health, (World Veterinary Association, 2011).

How can prudent or judicious use be measured and assessed? What may be prudent to someone may be everyday practice and usage to someone else. This is difficult to standardize and maintain accordingly. The AVMA states that judicious use of antibiotics incorporates the following characteristics:

- Preventive strategies, such as appropriate husbandry and hygiene, routine health monitoring, and immunization, should be emphasized.
- Judicious use of antimicrobials, when under the direction of a veterinarian, should meet all requirements of a veterinarian-client-patient relationship.
- Regimens for therapeutic antimicrobial use should be optimized using current pharmacological information and principles.
- Use narrow spectrum antimicrobials whenever appropriate.
- Veterinarians should work with those responsible for the care of animals to use antimicrobials judiciously regardless of the distribution system through which the antimicrobial was obtained.
- Accurate records of treatment and outcome should be used to evaluate therapeutic regimens.
- Therapeutic exposure to antimicrobials should be minimized by treating only for as long as needed for the desired clinical response, (AVMA, 2010).
- Antimicrobials considered important in treating refractory infections in human or veterinary medicine should be used in animals only after careful review and reasonable justification. Consider using other antimicrobials for initial therapy.

Based on the criteria necessary to practice judicious use, the use of antibiotics as growth promoters, contradicts the very idea of prudent use. Veterinarians are not always used as a source for prescribing antibiotics. Many can be purchased at feed stores and the quantities that are administered to animals are unknown because the administration of the medication is usually performed by farm laborers. The use of a narrow spectrum of activity antibiotic is clearly not employed with growth promoters as these are utilized primarily for the purpose of combating a wide variety of ailments that necessitate the use of a broad spectrum antibiotic.

There appears to be a general lack of acceptance among veterinarians and food producers, especially in the United States, regarding the resistance in the agricultural industry. The major reason for this lack of acceptance is not due to awareness or inadequate education or training, but has to do with the perception there is a relative lack of concrete examples clearly documenting the impacts, (WHO, McEwen, 2001). There is conflict between those within the scientific community that believe there is enough evidence that warrants policies that call for risk-reduction and those that believe there is a need for more evidence on the problem before new policies are implemented.

Some other reasons for the apprehension of banning growth promoter usage include

1) concern of increased cost to the consumer
2) decreased incentive for new drug development
3) poorer production efficiency
4) compensatory increases in prophylaxis or therapy
5) increases in the incidence of infectious disease in animals

6) limitations on the ability of veterinarians and farmers to treat and prevent disease, (McEwen, et al, 2002).

A human physician is more apt to encountering patients with resistance in hospitals and other community-derived pathogens. They see and treat these patients and are able to follow through with the course of treatment or document the mortality of that patient. The complexity of the food industry—production, processing, distribution and food service system in industrialized countries makes it extremely difficult to trace infections and resistance genes. If people do not believe that their practices and behaviors create public health risks, it is more difficult for them to change their behaviors, (WHO, McEwen, 2001).

The general feeling among the veterinary and animal production communities is that the benefits of antimicrobial use in treating and preventing infectious disease in animals far outweighs the risks associated with their use in animals. As long as this feeling dominates, then it will be a major barrier to implement strategies intended to reduce any risks that are indeed present, (WHO, McEwen, 2001).

Education and Alternatives to Antimicrobials

Educating veterinarians on the practices and how to implement change among their clients is extremely important. This, in my opinion, must be one of the first steps. The relationship between the veterinarian and the agricultural unit should be strong enough to invoke trust in order to have a smooth transition and new way of rearing food producing animals.

Veterinary students should be taught the fundamentals of animal husbandry; this is all too often overlooked or skimmed through during the education process. Dr Ezra Barzilay of

NARMS states that “By stressing the importance of proper prescribing practices during their formative years, the students will be more responsible and more aware of the issues of prescribing behaviors when they ultimately become clinicians,” (Infectious Disease News 2010).

Steps to prevent or control infectious diseases include improved husbandry practices, quarantines and other biosecurity measures and vaccinations. Some other recommendations include genetic selection to enhance disease resistance, uses of antiseptics such as teat dipping to prevent mastitis, vector control, and use of probiotics or other competitive microorganisms to exclude pathogens (Dial, et al, 1992). Controlling viral infections can greatly reduce the number of secondary bacterial infections from developing and this will reduce the need for therapeutic antimicrobial therapy.

In a study conducted by Casey et al 2007, a group of fifteen weaned pigs were administered control milk or a mixture of five probiotic strains as either a milk fermentate or milk suspension for 30 days. The mixture contained strains of the probiotic *Lactobacillus spp.* and *Pediococcus pentosaceous.* After six days of probiotic administration, the pigs were challenged orally with *Salmonella typhimurium*. The clinical health of the animals and the microbiological composition of their feces were monitored for 23 days post-infection. The animals treated with a probiotic showed a reduced incidence, severity and duration of diarrhea. They also gained weight at a faster rate than the control pigs. Based on the results of this study, the use of probiotic bacteria did improve the clinical and microbiological outcome of infection with *Salmonella typhimurium* infection and it was concluded that the use of probiotics can be of significant benefit in the food industry.

Postweaning diarrhea is an important cause of death in swine and most of the research that has been conducted with the use of probiotics has been directed to control the enterotoxigenic *E.coli* serotype K88 (Mulder, et al 1997.) The use of probiotics has also been incorporated into the diets of beef cattle, sheep and poultry in order to promote growth, increasing feed efficiency, enhancing milk and egg production, improving meat and milk quality and ultimately to prevent infectious diseases. As stated earlier, in the study conducted by Casey, probiotic administration did show a reduced incidence, severity and duration of diarrhea in weaned piglets.

Research focused on antibiotic resistance and the genetics involved in the development of resistance would not only benefit the scientific community but the general public health. If we can understand the mechanisms by which resistance develops especially by the usage of antibiotics then it may facilitate the ability to control overprescribing and enforce regulatory policies that are already in place.

Management Practices

As stated earlier if, management practices and intensified rearing were improved, many of the infectious agents that result from overcrowding and unsanitary conditions would be reduced. Animals should be treated with respect and allowed to fulfill their instinctive behaviors. "A good animal welfare status will help the animal to maintain its natural resistance against diseases. Successful animal husbandry depends also upon policies of good veterinary governance," (WVA, 2011).

If production units were not heavily influenced by economics, it would allow them to improve living conditions by making appropriate changes. This requires extra funds that perhaps are not available to them. The intensification of food animals has evolved to what it is now after 50+ years ago since the beginning of its use (Dibner and Richards, 2005). As consumers are becoming more aware of where their food comes from and the humane treatment of animals, production units will feel the pressure to improve living conditions and the ways these animals are fed.

Conclusion

It is my sincere hope that the United States will change and remedy the current management practices for food producing animals, not just for the prevention of infectious diseases and reducing the amount of antimicrobial use but also for adherence to welfare standards. Very often we do not consider where that piece of meat came from, where the chickens that provided those eggs were residing or how that dairy cow was treated prior to being milked. These living conditions and the ability to display natural behaviors should be maintained at an acceptable standard. Restriction of natural behaviors increase stress and can result in increased susceptibility to infectious agents. The consumer should be aware of where food comes from and how they are cared for.

Pharmaceutical companies may be conducting research for the development of antibiotics to deal with antibiotic resistant strains but it appears there has been little done with improving antibiotic usage among the veterinary community. The attitude amongst the veterinary community needs to change and we must also be responsible for practicing and prescribing medications appropriately.

The pending bills PAMTA and STAAR are necessary for implementing the desired change within the agricultural industry. These two bills will really animal and public health tremendously in a positive direction.

Forcing individuals within the agricultural industry to make fundamental changes in their practices will not bode well. This may result in angry workers that may lose sight of the task at hand, providing quality care to farm producing animals. Theoretically speaking, if the idea of governmentality is implemented, this should have the desired effect among workers in the agricultural industry. Governmentality, although the rules are devised by government officials, allows the industry to make the choices and decisions for themselves. As stated earlier, the idea that the industry is to feel as if they are in control of their livelihood and making decisions for the betterment of their field without feeling forced by government regulations. It engages the industry to meet the political agenda; to abolish the use of growth promoters. Preferred results won’t happen overnight but so long as the process is underway, positive projected results will follow through.

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Appendix A

Definition of terms

Commensal bacteria- normal flora of bacteria that reside within the body but do not pose any harm

Food producing animals—animals that provide the human population as well as the large pet food industry with meat, milk and eggs.

Antimicrobial Resistance—a property of microorganisms that confers the ability to inactivate or elude antimicrobials or a mechanism that blocks the inhibitory or killing effects of antimicrobials

Non-therapeutic antimicrobials—antibiotics, antivirals or antifungal medications that are used in doses that have been described as not having therapeutic advantages

Antibiotics a chemical substance produced by a microorganism which has the capacity, in dilute solutions, to inhibit the growth of or to kill other microorganisms

Antimicrobials an agent that kills microorganisms or suppresses their multiplication or growth

Enteric bacteria- bacteria that reside within the gastrointestinal tract, i.e.- *Escherichia coli, Campylobacter spp., Salmonella spp.*

Nosocomial infections- hospital –acquired diseases while hospitalized

MAC- acronym for MacConkey's agar a selective media that inhibits the growth of gram-positive bacteria but allow gram-negative bacteria to thrive

MIC- acronym minimum inhibitory concentration- the smallest amount of the antibiotic that inhibits the multiplication of the pathogen

AGP- acronym for antimicrobial growth promoters

Appendix B

IRB exemption letter

EMORY UNIVERSITY | Institutional Review Board

TO: Wendy Cuevas-Espelid
Principal Investigator

DATE: November 2, 2010

RE: **Notification of Exempt Determination**
IRB00046254
Non-therapeutic use of antibiotics in food producing animals

Thank you for submitting an application in eIRB. We reviewed the application and determined on **11/02/2010** that it meets the criteria for exemption under 45 CFR 46.101(b)(2) and thus is exempt from further IRB review.

This determination is good indefinitely unless something changes substantively in the project that affects our analysis. The PI is responsible for contacting the IRB for clarification about any substantive changes in the project. Therefore, please do notify us if you plan to:

- Add a cohort of children to a survey or interview project, or to a study involving the observation of public behavior in which the investigators are participating.
- Change the study design so that the project no longer meets the exempt categories (e.g., adding a medical intervention or accessing identifiable and potentially damaging data)
- Make any other kind of change that does not appear in the list below.

Please do not notify us of the following kinds of changes:

- Change in personnel, except for the PI
- Change in location
- Change in number of subjects to be enrolled or age range for adults
- Changes in wording or formatting of data collection instruments that have no substantive impact on the study design

For more information about the exemption categories, please see our Policies & Procedures at www.irb.emory.edu. In future correspondence about this study, please refer to the IRB file number, the name of the Principal Investigator, and the study title. Thank you.

Sincerely,
Carol Corkran, MPH, CIP
Senior Research Protocol Analyst
This letter has been digitally signed

Appendix C

Interview questions

The following questions were administered via email to the interviewees.

1. Was the use of antibiotics as growth promoters accepted among the veterinary community?

2. Was it discussed with farmers?

    a. Did they accept the use of antibiotics as growth promoters or were they hesitant?

3. Do you find that the level of animal husbandry has improved since the ban?

4. Did the ban affect the economic stability of the agricultural industry in your country?

5. Do you feel that the quality of products milk/meat from food producing animals is superior prior to the ban?

6. Why do you feel the United States still practices the method of antibiotics in low levels as growth promoters?

7. Despite the evidence based studies that prove that low level use of antibiotics selects for resistance among bacteria, why, in your opinion, would the AVMA dispute policies against its use?

8. How do you feel about present day animal husbandry practices in your country?

9. What makes your country so different in its practices?

    a. Does capitalism play a role in the methods practiced in the United States or the progression of industrialized nations?

10. Do you feel that big business takes precedence over the welfare of the food producing animals?

Table 1 Antibiotics currently allowed for use in food producing animals

PURPOSE	Cattle	Swine	Poultry	Fish
Treatment of various infections	Amoxicillin	Amoxicillin	Erythromycin	Ormetoprim
	Cephapirin	Ampicillin	Fluoroquinolone	Sulfonamide
	Erythromycin	Chlortetracycline	Gentamicin	Oxytetracycline
	Fluoroquinolone	Gentamicin	Neomycin	
	Gentamicin	Lincomycin	Penicillin	
	Novobiocin	Sulfamethazine	Spectinomycin	
	Penicillin	Tiamulin	Tetracycline	
	Sulfonamides	Tylosin	Tylosin	
	Tilmicosin		Virginiamycin	
	Tylosin			
Growth and feed efficiency	Bacitracin	Asanilic acid	Bambermycin	
	Chlortetracycline	Bacitracin	Bacitracin	
	Lasalocid	Bambermycin	Chlortetracycline	
	Monensin	Chlortetracycline	Penicillin	
	oxytetracycline	Erythromycin	Tylosin	
		Penicillin	Virginiamycin	
		Tiamulin		
		Tylosin		
		Virginiamycin		

Adapted from National Academy Press 1999.

Table 2 Antimicrobials Used for Growth Promotion in Europe and United States

Antimicrobial group	Antimicrobial growth promoter	United States	Europe	Related to antibiotic used in human treatment
Polypeptides	Bacitracin	In use	Banned 1999	Bacitracin
Flavofosfolipid	Flavomycin/Bambermycin	In use	Banned 2006	None
Glycopeptides	Avoparcin	Not used	Banned 2006	Vancomycin, Teicoplanin
Ionophores	Monensin Salinomycin	Not used	Banned 2006	None
macrolides	tylosin	In use	Banned 1999	Macrolides (erythromycin)
Oligosaccharides	Avilamycin	Not used	Banned 2006	Evernimicin
Quinoxalines	Carbadox Olaquindox	In use Not used	Until 1999 Until 1999	None None
Streptogramins	Virginiamycin	In use	Banned 1999	Quinupristin/ Dalfopristin, Pristinamycin
Sulfonamides	Sulfathiazole	In use	Not used	Sulfonamides
Tetracyclines	Tetracyclines	In use	Not used	Tetracyclines
Penicillin	Penicillin	In use	Not used	penicillin
Pleuromuttilin	Tiamulin	In use	Prophylactic	none

http://ddr.nal.usda.gov/bitstream/10113/13399/1/IND43984018.pdf

Table 3 Proposed legislations and outcomes

Bill	Congress	Committee	Sponsor	General debate
H.R. 2932 PAMTA	108th	House energy and commerce	Sherrod Brown (-OH)	Dead
S. 1460 PAMTA	108th	Health, Education, Labor, and Pensions	Edward Kennedy (D-MA)	Dead
H.R. 2562 PAMTA	109th	House energy and commerce	Sherrod Brown (D-OH)	Dead
S. 742 PAMTA	109th	Health, Education, Labor, and Pensions	Olympia Snowe (R-ME)	Dead
H.R. 962 PAMTA	110th	House energy and commerce	Louise Slaughter (D-NY)	Dead
S. 549 PAMTA	110th	Health, Education, Labor, and Pensions	Edward Kennedy (D-MA)	Dead
H.R. 1549 PAMTA	111th	House energy and commerce	Louise Slaughter (D-NY)	Dead
S. 619 PAMTA	111th	Health, Education, Labor, and Pensions	Edward Kennedy (D-MA)	Dead
H.R. 965 PAMTA	112th	House energy and commerce	Louise Slaughter (D-NY)	Awaiting results
STARR Act H.R. 3697	110th	House energy and commerce	Jim Matheson (D-UT)	Dead
H.R. 2400 STARR Act	111th	House energy and commerce	Jim Matheson (D-UT)	Dead

Information obtained from www.Thomas.loc.gov.

Table 4 Antimicrobial drugs Approved for use in Food-producing Animals: 2009 Sales and Distribution Data Reported by Drug Class

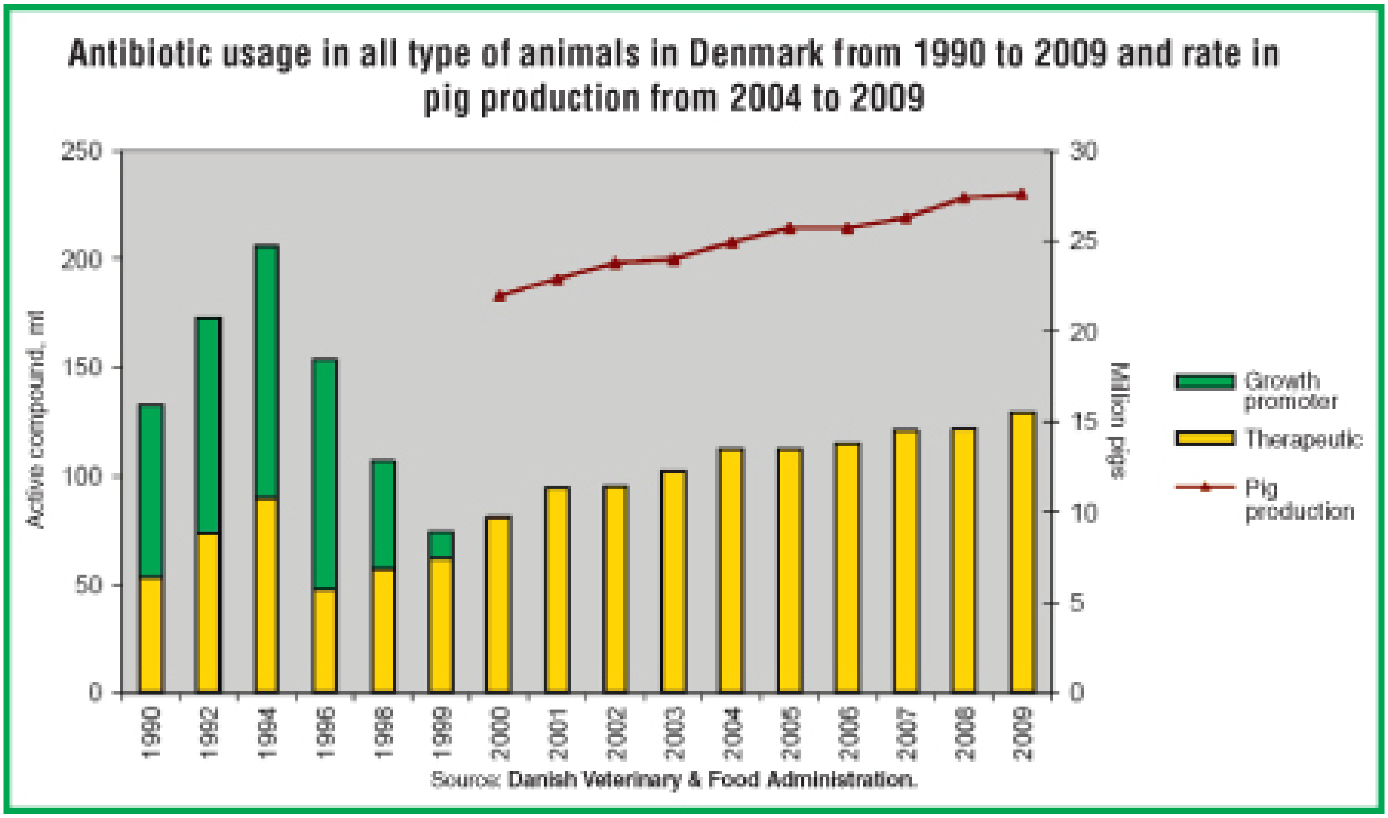
	Antimicrobial Class	Annual Totals (kg)
Domestic	Aminoglycosides	339,678
	Cephalosporins	41,328
	Ionophores	3,740,627
	Lincosamides	115,837
	Macrolides	861,985
	Penicillins	610,514
	Sulfas	517,873
	Tetracyclines	4,611,892
	NIR[1]	2,227,366
Export	Tetracyclines	515,819
	NIRE[2]	1,115,728
Total amount		14,698,647 kg

Obtained from 2009 Summary Report on Antimicrobials Sold or distributed for use in Food-Producing Animals

[1]NIR = Not independently reported. Antimicrobial classes for which there were less than three distinct sponsors active marketing products domestically were not independently reported. These classes include: aminocoumarins, amphenicols, diaminopyrimidines, fluroquinolones, glycolipids, pleuromutilins, polypeptides, quinoxalines and streptogramins.

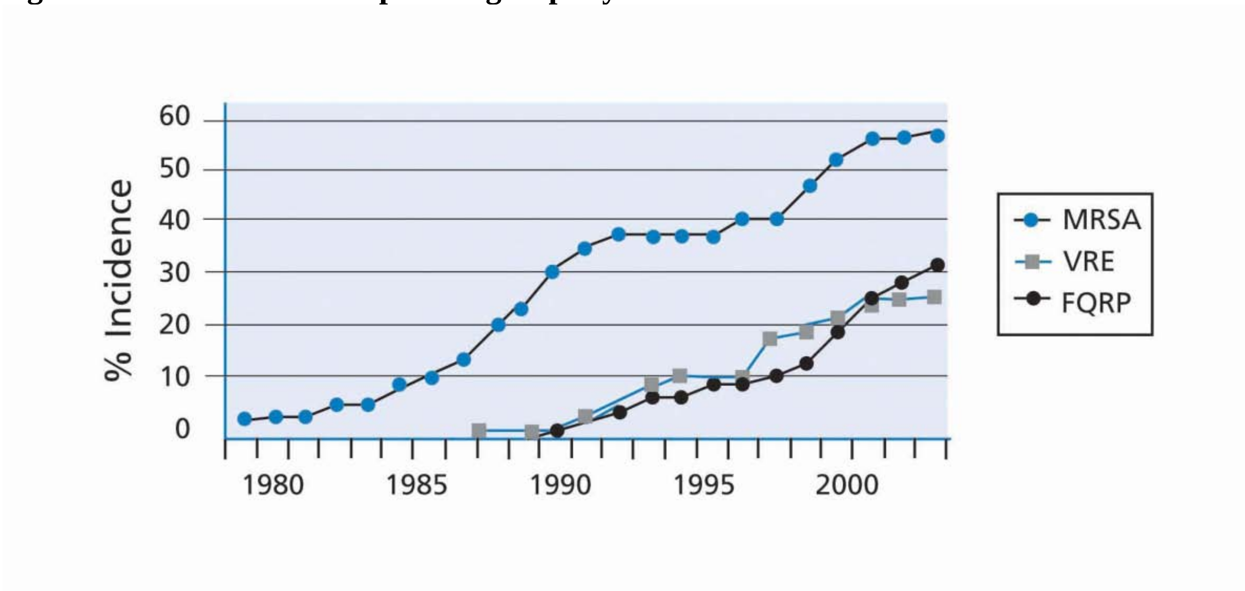
[2]NIRE = Not independently reported export. Antimicrobial classes for which there were less than three distinct sponsors exporting products were not independently reported. These classes include: aminocoumarins, aminoglycosides, amphenicols, cephalosporins, diaminopyrimidines, fluroquinolones, glycolipids, ionophores, lincosamides, macrolides, penicillins, pleuromutilins, polypeptides, quinoxalines, streptogramins and sulfas.

Figure 1 Antibiotic Usage of animals in Denmark



Obtained from Schuff, 2010.

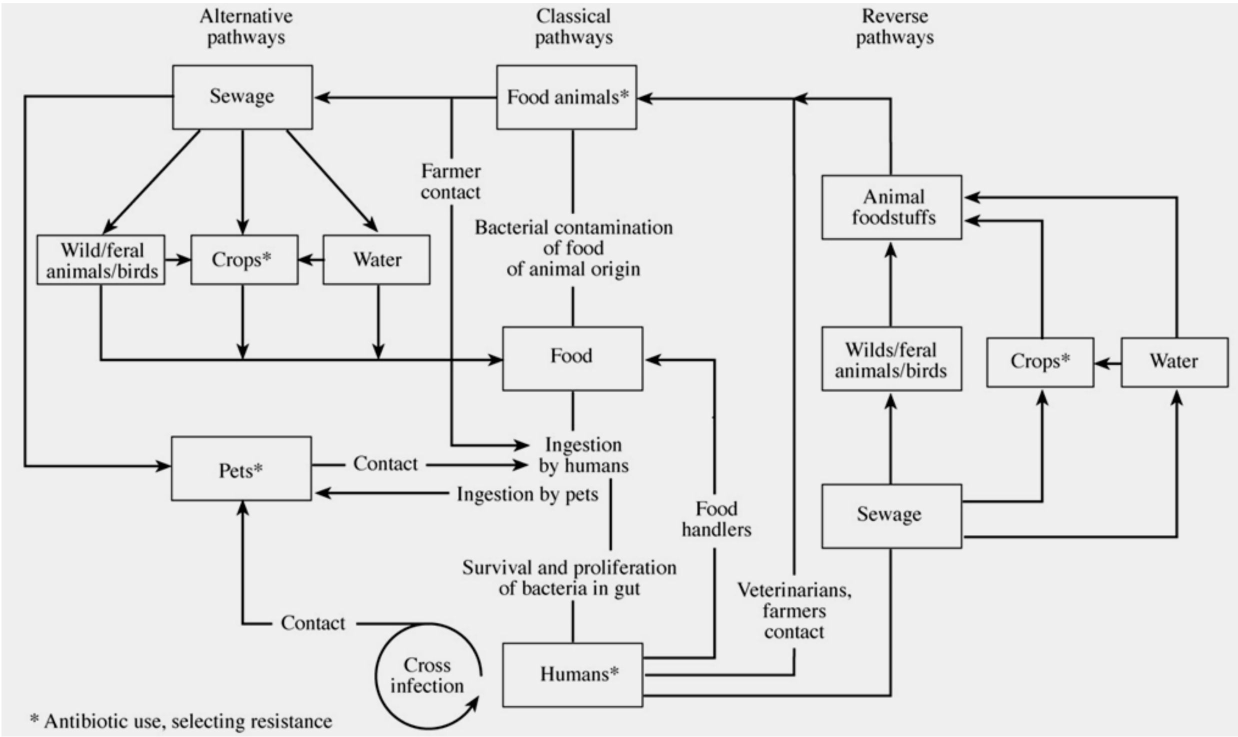
Figure 2 Resistant Strains Spreading Rapidly from 1980-2005



Source: Centers for Disease Control and Prevention

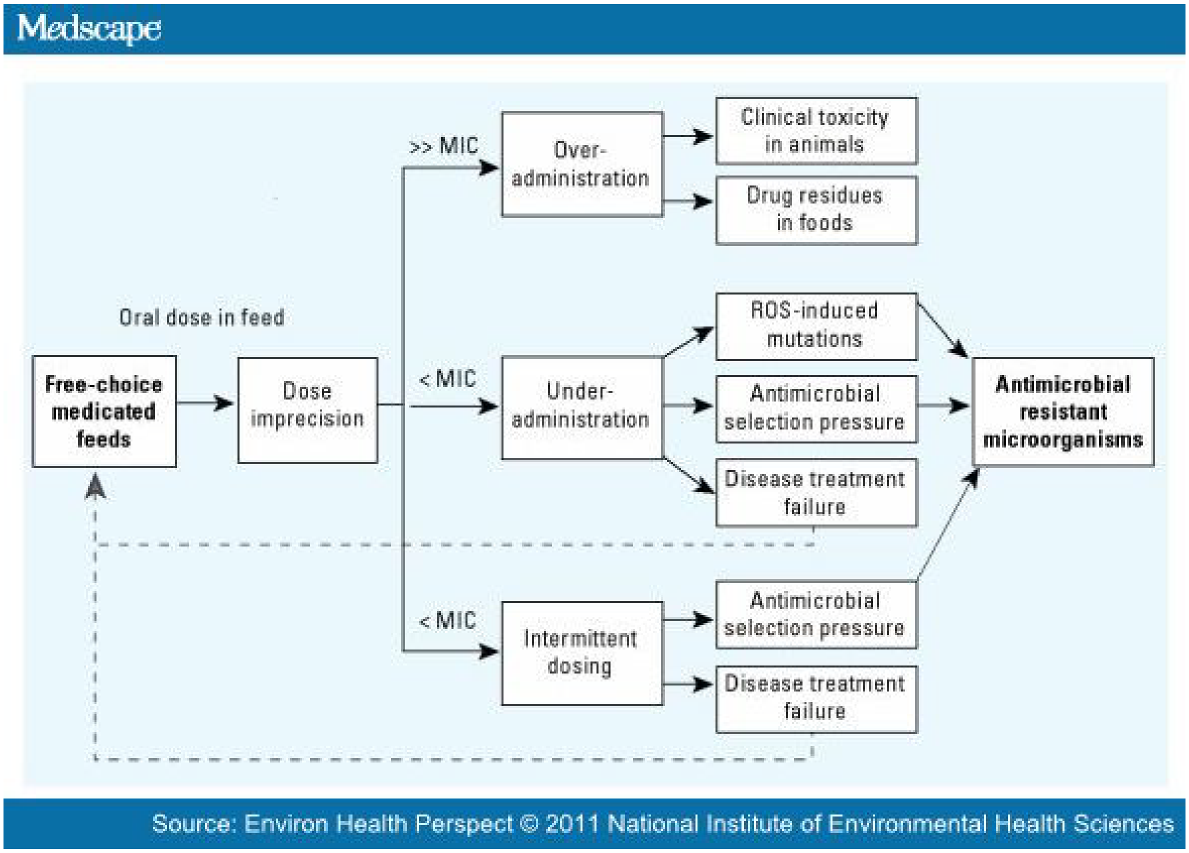
FQRP Fluoroquinolone resistant pseudomonas aeruginosa
VRE- vancomycin Resistant enterococcus
MRSA- methicilline resistant staphylococcus aureus

Figure 3 Ecological impact of the use of antibiotics in food animals



Phillips, et al 2004

Figure 4 Flow chart depicting development of antibiotic resistance through dose imprecision



(Love, et al 2011)