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The public health implications of antibiotic use in  
dairy cattle and management strategies to ensure their  
judicious use

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## **Introduction:**

Dairy producers have used antibiotics as part of their on-farm management practices for decades. Antibiotics cure bacterial infections by killing or injuring the bacteria responsible for causing the infection, and can be a useful tool in treating a wide variety of cattle illnesses, from mammary gland infections (mastitis) to infections resulting from retained placentas among a myriad of other dairy cattle illnesses. And when used properly, antibiotics can be a valuable tool for dairy producers to treat ill animals. But the dairy farm landscape has changed drastically, with dairy producers managing larger herds of cattle to maximize milk production and ultimately profits<sup>1</sup>. Larger herds are more difficult to manage and monitor, and subsequently the focus diverts from management at the cow level and *preventing* cattle illnesses and evolves into waiting for cattle to become ill and then treating them accordingly. Consequently, dairy producers may rely more heavily on antibiotics, thereby increasing the risk of antibiotic residues in the milk they sell. Misuse and over-use of antibiotics on dairy farms could have serious public health implications if solutions are not sought to minimize their use on the farm—especially –extra-label use.” The minimization of antibiotic use and the prevention of antibiotic residues must begin on the farm through more intensive management practices at the cow level that emphasize disease prevention through proper animal husbandry and management.

## **Recent Trends in the Dairy Industry:**

In September 2010 the National Agricultural Statistics Service (NASS), Agricultural Statistics Board, and the United States Department of Agriculture (USDA) released information regarding recent trends in dairy farming. The dairy industry in the United States has undergone significant structural change over the past eight years alone. Total milk cow operations have declined significantly, while the number of large operations has increased<sup>1</sup>. The number of milk cow operations continues to decline in the United States. Data show a 33 percent decline in cow

operations from 2001 to 2009<sup>1</sup>. Despite the large decrease in milk cow operations during this time period, both milk production and milk cow numbers have been on the rise. Milk production increased 15 percent from 2001 to 2009<sup>1</sup>. Although the overall number of milk cow operations has declined since 2001, the number of operations with 500 or more milk cows has increased by 20 percent<sup>1</sup>. The largest size group (operations with 2,000 or more milk cows) has shown the greatest percentage change from 2001, increasing from 325 in 2001 to 740 in 2009, a gain of 128 percent<sup>1</sup>.

While larger operations have grown in number, smaller operations have declined in number. Operations with less than 500 head decreased 35 percent, from 94,665 in 2001 to 61,650 in 2009. Operations with 2,000 or more head accounted for 30 percent of inventory in 2009, up from only 12 percent in 2001<sup>1</sup>. Since 2001, the overall trend in the United States dairy industry has been trending toward larger operations (farms with 500 or more head of milk cows) that have a greater share of total milk cow inventory and a greater share of total milk production<sup>1</sup>. In 2009, operations with 500 or more head accounted for 5 percent of the total milk cow operations, 56 percent of the milk cows, and 60 percent of the milk production.

### **Survey of Antibiotic Use on Dairies:**

Antibiotic treatment of dairy cows for infectious diseases is a relatively common and necessary occurrence<sup>2</sup>, and likely even more so given the recent trends stated above. As population densities of cows grow on dairies they could potentially become more susceptible to diseases and infections. Large operations are more difficult to manage and potential problems might take longer to surface given the sheer numbers of animals to monitor. The overall availability and use of antibiotics in the dairy industry have been estimated in a US population-based survey; however, there are few data available on the use of individual antibiotics.

Measuring antibiotic use on dairy farms is a complex undertaking due to the difficulty in obtaining accurate assessments on dosage and duration of treatments. Antibiotics are administered to animals through a variety of methods including injections (e.g., intramuscular, intravenous, or subcutaneous), orally, topically, or via intramammary or intrauterine infusion. A survey of US veterinarians found that the drugs most often used or prescribed were antibiotics, followed by anti-inflammatories and tranquilizers or analgesics<sup>3</sup>.

Several types of antibiotics are commonly used in food animals. A survey of US veterinarians reported that antibiotics were the drugs most often used to treat lactating dairy cows. The most common reason for treatment was mastitis therapy<sup>4</sup>. A 2004 survey of dairy producers in several high-producing dairy states studied the antibiotic use strategies used on nearly 100 conventional and 30 organic dairies. They found that 71 percent of the dairies kept antibiotic treatment records for lactating dairy cows<sup>5</sup>. Slightly over half of the dairies kept records of treatment of dry-cows and only a third kept records of antibiotic treatment in replacement heifers. A dry-cow is a non-lactating cow, usually in the final months of her pregnancy, preparing to give birth to another calf so she can rejoin the milking herd. Replacement heifers are growing calves that will one day become pregnant, give birth, and join the milking herd. The dairy producers with organic dairy herds kept even fewer records than the conventional dairy producers, perhaps due to significantly fewer treatments. The dairy producers in the survey were asked a variety of questions regarding the use of antibiotics on the farm. Of the dairy producers surveyed, 85 percent of dairy producers reported treating up to 25 percent of their milking cows at least once with antibiotics “within the previous 60-days”<sup>5</sup>. Over 90 percent of organic dairy producers surveyed reported they had treated no milking cows with antibiotics and, the remainder of the organic dairy producers treated less than 10 percent of their cows<sup>5</sup>. The

most commonly used antibiotics on conventional dairies were penicillin (86 percent), cephalosporin (78 percent), and tetracyclines (41 percent)<sup>5</sup>. Nearly all dairy producers also used antibiotics to treat adult cows with respiratory conditions and to a lesser extent mastitis, metritis, and foot problems<sup>5</sup>. Ceftiofur was by far the common antibiotic used to treat respiratory disease followed by tetracyclines and penicillin<sup>5</sup>. For the treatment of mastitis, penicillin, ampicillin, and tetracyclines were commonly used<sup>5</sup>. Penicillin and ceftiofur were the antibiotics of choice for metritis or retained placentas as well as foot problems. Ninety-eight percent of the conventional dairy herds surveyed used intramammary dry-cow antibiotic treatment while only 6.3 percent of organic herds used intramammary dry-cow therapy. Instead, they opted for non-antibiotic products for dry-cow therapy<sup>5</sup>.

#### **Antibiotic Overuse and Misuse on Dairies :**

There are three classes of animal drugs: Over-the-Counter, Prescription, and Veterinary Feed Directive. Over-the-Counter drugs can be sold by any person or establishment without a prescription from a veterinarian<sup>6</sup>. Prescription drugs can only be sold to the public by a veterinarian or pharmacist, and only with the written prescription of a veterinarian. A Veterinary Feed Directive is a drug intended for use in or on feed, which is limited by an approved application to use under the professional supervision of a licensed veterinarian<sup>6</sup>. Currently, no Veterinary Feed Directive products are approved for use in cattle. Any use of a drug not specifically listed on the label is called “extra-label drug use” and is regulated by the Food and Drug Administration (FDA) under the Animal Medicinal Drug Use Clarification Act (AMDUCA) of 1994<sup>6</sup>. Using a prescription or over-the-counter drug in an extra-label manner is illegal unless it is specifically recommended under the guidance of a veterinarian working in the context of a Veterinary-Client-Patient Relationship (VCPR). Some examples of extra-label use

of animal drugs are changing the dose or frequency of treatment as listed on the drug label; changing the route of administration, such as giving a drug intended for intravenous use intramuscularly; giving a drug for an indication not listed on the label; using a drug for a different production class than listed on the label, such as administering a drug only approved for non-lactating cows to a lactating cow; and changing the withholding time. Using a drug in an extra-label manner can make it difficult to determine the proper milk withholding time<sup>6</sup>. In these instances it might be necessary to sample the treated animal and use an appropriate screening test to determine if the antibiotic residue has cleared the cow. In some instances residues can persist for weeks<sup>6</sup>. Miscalculating milk withholding times and using animal drugs in an extra-label manner outside the limits of federal regulations can lead to antibiotic residues which have both financial implications for the dairy producer and public health implications for consumers.

### **Public Health Implications of Antibiotic Misuse, Overuse, and Drug Residues:**

The public health implications of antibiotic misuse, overuse, and residues are two-fold: drug allergies account for approximately 10 percent of all adverse drug reactions, and exposure to antibiotics and their misuse has been linked to antibiotic resistance and the emergence of “super bugs” completely resistant to traditional forms of antibiotic therapy<sup>7</sup>. Allergies to antibiotics do not often occur the first time an individual is exposed to the drug. The mechanism of a drug allergy is an immune response where the immune system overreacts to the drug which is viewed as a chemical invader or antigen<sup>8</sup>. The body produces antibodies to the antigen and stores the antibodies in specialized cells. The antibodies produced in an allergic reaction are Immunoglobulin E (IgE). When an individual is exposed to the same drug a second time the antibodies signal the cells to release chemicals called mediators. The effects of these mediators on organs and other cells cause the symptoms of the reaction. These symptoms range from a

mild localized rash to serious effects on vital systems<sup>8</sup>. According to the American Academy of Allergy Asthma & Immunology more than half of all US citizens test positive to one or more allergens<sup>7</sup>. With regards to drug allergies penicillin allergy is the most common cause of drug-induced anaphylaxis, causing an average of 400 deaths annually<sup>7</sup>. Other common drug allergies include sulfa drugs and tetracyclines. Between 29 and 65 percent of patients with HIV/AIDS are allergic to sulfonamide drugs, compared to 2 to 4 percent of other individuals<sup>7</sup>. Drug allergies are a serious public health concern, making judicious use of antibiotics in both human and animal medicine vital. But there is yet a second public health impact of antibiotic use, and that is antibiotic resistance.

Antibiotic resistance is the ability of bacteria or other microbes to resist the effects of an antibiotic. Bacteria do this through several mechanisms. Some bacteria develop the ability to neutralize the antibiotic before it can do harm, others can rapidly pump the antibiotic out, and still others can change the antibiotic attack site so it cannot affect the function of the bacteria<sup>9</sup>. Antibiotics kill or inhibit the growth of susceptible bacteria. Sometimes one of the bacteria survives because it has the ability to neutralize or evade the effect of the antibiotic; that one bacterium can then multiply and replace all the bacteria that were killed off<sup>9</sup>. Exposure to antibiotics provides selective pressure, which makes the surviving bacteria more likely to be resistant. In addition, bacteria that were at one time susceptible to an antibiotic can acquire resistance through the mutation of their genetic material or by acquiring pieces of DNA that code for the resistance properties from other bacteria<sup>9</sup>. The DNA codes for resistance can be grouped into a single, easily transferable package. This means that bacteria can become resistant to many antimicrobial agents because of the transfer of one piece of DNA<sup>9</sup>.

Antibiotic resistance is a food safety problem for several reasons. First, the incidence of

antibiotic resistance is increasing, especially to antibiotics known as fluoroquinolones and third-generation cephalosporins<sup>10</sup>. These antibiotics are commonly used to treat serious infections caused by bacterial pathogens frequently found in food, such as *Salmonella* and *Campylobacter*. Each year, several million people in the United States are infected with *Salmonella* and *Campylobacter*, which usually cause diarrhea that lasts about a week<sup>10</sup>. Antibiotics are not recommended for treatment of most of these diarrheal illnesses, but are used to prevent complications in infants, persons with weakened immune systems, and older persons. Antibiotics may be life-saving for several thousand people each year who have serious invasive infections, such as bacteremia (infection in the bloodstream) and meningitis (infection of the lining of the brain and spinal cord). *Salmonella* infections are treated with ampicillin, trimethoprim-sulfamethoxazole, fluoroquinolones or third-generation cephalosporins, but some *Salmonella* and *Campylobacter* infections have become resistant to these medicines<sup>10</sup>.

One resistant bacterium that has received increased public attention is MRSA (Methicillin-Resistant *Staphylococcus aureus*). It is a bacterial infection highly resistant to some antibiotics caused by bacteria normally residing on the skin. When the bacteria enter the body through a cut or a sore they can cause serious infections that are resistant to many common antibiotics<sup>11</sup>. For this reason it has received an increasing amount of public scrutiny. One thing of consequence is MRSA is currently still treatable with certain classes of antibiotics. There are new “superbugs” emerging, however, that appear to show resistance to even the strongest antibiotics; those considered the “last line of defense.” *Klebsiella* are Gram-negative bacteria that can cause different types of infections, including pneumonia, bloodstream infections, wound or surgical site infections, and meningitis<sup>12</sup>. Increasingly, *Klebsiella* bacteria have developed antimicrobial resistance, most recently to the class of antibiotics known as carbapenems<sup>12</sup>. Carbapenems are

the strongest known antibiotics in existence; there is no other recourse for treatment, and this creates a serious problem. In healthcare settings, *Klebsiella* infections commonly occur among sick patients who are receiving treatment for other conditions. Patients whose care requires devices like ventilators or intravenous catheters, and patients who are taking long courses of certain antibiotics are most at risk for CRKP (Carbapenem-Resistant *Klebsiella Pneumoniae*)<sup>12</sup>. The evolution of these types of “superbugs” that are resistant to many if not all antibiotics is a major concern to disease control experts, and if current trends continue, this problem will grow.

A second reason that antibiotic resistance is a food safety problem is that more people could become ill. Ordinarily, healthy persons who consume a few *Salmonella* may carry them for a few weeks without having any symptoms, because those few *Salmonella* are held in check by the normal bacteria in their intestines. However, even a few antibiotic-resistant *Salmonella* in food would cause illness if the person who consumes the contaminated food then takes an antibiotic for another reason. The antibiotic can kill normal bacteria in the gut, letting a few *Salmonella* that ordinarily would be unlikely to cause any adverse effects, take over and cause illness<sup>10</sup>.

A third reason that antibiotic resistance is a food safety problem is that the food supply may be a source of antibiotic-resistant genes. Harmless bacteria present in food-producing animals could be resistant, and humans could acquire these bacteria when they eat meat products from these animals. Once ingested, resistant genes from these bacteria could be transferred to bacteria that cause disease. Quantifying the extent to which this contributes to a food safety problem is difficult due to the difficulty in establishing a causal relationship<sup>10</sup>.

The National Antimicrobial Resistance Monitoring System is a collaborative effort between the Centers for Disease Control and Prevention, the Food and Drug Administration

Center for Veterinary Medicine, the USDA Food Safety and Inspection Service and Agricultural Research Service<sup>13</sup>. It is a national public health surveillance system that tracks antibiotic resistance in foodborne bacteria. The NARMS program was established in 1996 and monitors antimicrobial susceptibility among enteric bacteria from humans, retail meats, and food animals. The major bacteria currently under surveillance are *Salmonella*, *Campylobacter*, *Escherichia coli*, and *Enterococcus*. NARMS also collaborates with antimicrobial resistance monitoring systems in other countries, to work toward international harmonization of testing and reporting<sup>13</sup>. The primary objectives of NARMS are to:

- Monitor trends in antimicrobial resistance among foodborne bacteria from humans, retail meats, and animals
- Disseminate timely information on antimicrobial resistance to promote interventions that reduce resistance among foodborne bacteria
- Conduct research to better understand the emergence, persistence, and spread of antimicrobial resistance
- Assist the FDA in making decisions related to the approval of safe and effective antimicrobial drugs for animals

Bacterial resistance is a growing problem in the United States and on-farm antibiotic use is contributing to this overall issue.

### **Regulatory Oversight and Monitoring of Antibiotic Residues:**

Because antibiotic use is more or less ubiquitous in the dairy industry, it is necessary to have regulations in place to ensure the safety of the food supply. Milk sold with antibiotic residues meets the Food and Drug Administration's definition of an adulterated food and also contributes to the human health concerns associated with antibiotic use on dairy farms. The Food

and Drug Administration (FDA) is the federal agency responsible for enforcing the Federal Food, Drug and Cosmetic Act, 21 U.S.C. 301. Included within the FDA's responsibilities under the Act is the responsibility for regulation of foods shipped in interstate commerce including milk and milk products<sup>14</sup>. The National Conference on Interstate Milk Shipments (NCIMS) is a voluntary organization directed and controlled by the member States and open to all persons interested in its objective of promoting the availability of a high quality milk supply<sup>15</sup>. It is governed by an Executive Board whose members include representatives from state departments of health and agriculture, the FDA, the U.S. Department of Agriculture and industry. Through their collaborative efforts, and a memorandum of understanding, the FDA and the NCIMS have developed a cooperative, federal-state program (the Interstate Milk Shipper Program) to ensure the sanitary quality of milk and milk products shipped interstate<sup>15</sup>. The Program is operated primarily by the States, with FDA providing varying degrees of scientific, technical and inspection assistance as provided by FDA Publication No. 72-2022, Procedures Governing the Cooperative State-Public Health Service/Food and Drug Administration Program of the National Conference on Interstate Milk Shipments. The result has been the establishment of a viable and effective certification and enforcement program which has been of significant benefit to consumers<sup>15</sup>.

The Interstate Milk Shippers Program relies upon the Grade "A" Pasteurized Milk Ordinance and related technical documents referred to in the Procedures Manual for the sanitary standards, requirements and procedures it follows to ensure the safety and wholesomeness of Grade "A" milk and milk products. The Grade "A" Pasteurized Milk Ordinance (PMO) outlines the regulations pertaining to Grade "A" milk products.

Appendix N. of the PMO outlines the regulatory requirements pertinent to drug residue testing and farm surveillance. For example, it requires that industry screen bulk milk pick-up tankers for beta-lactam drug residues, regardless of the final use of the milk. Additional screening for other drug residues is also required through a random sampling program of bulk milk pick-up tankers. Individual customers can also request that milk be screened for drug residues in addition to beta-lactams<sup>16</sup>. Bulk milk pick-up tankers that test positive for antibiotics during the screening process are considered “presumptive positive” thereby necessitating a confirmation process where the sample is re-tested in duplicate. If one of both of these samples is positive the tanker is considered “confirmed positive” for antibiotic residues and the milk must be disposed of in a manner that removes it from the human or animal food chain, except where acceptably reconditioned under FDA Compliance Policy Guide (CPG 7126.20)<sup>16</sup>. Then it is necessary to determine which dairy producer’s milk was on that tanker and test them as well to determine who caused the bulk milk pick-up tanker to confirm positive for antibiotic residues; a process called producer trace-back. Any time milk is found to test as a confirmed positive for a drug residue, the Regulatory Agency must immediately suspend the producer's Grade "A" permit or equally effective measures must be taken to prevent the sale of milk containing drug residues<sup>16</sup>.

Future pick-ups are prohibited until subsequent testing reveals the milk is free of drug residue. The penalty incurred includes for the value of all milk on the contaminated load plus any costs associated with the disposition of the contaminated load. The Grade "A" producer's permit may be reinstated, to allow the sale of milk for human food, when a representative sample taken from the producer's milk is no longer positive for drug residue<sup>16</sup>.

Whenever a drug residue test is positive, an investigation must be conducted to determine the cause. The farm inspection is completed by the Regulatory Agency to determine the cause of the residue and actions taken to prevent future violations. In most cases the residue results from inadvertently milking a cow treated with antibiotics into the comingled bulk tank instead of ~~holding her out~~ and milking her into a separate pail. Should a dairy producer have three violations in a twelve month period, the Regulatory Agency initiates procedures to revoke the producer's Grade "A" permit<sup>16</sup>.

Regulatory documents like the PMO have helped keep dairy producers compliant and avoid drug residues that are costly for producers and threaten the health of consumers. The National Milk Drug Residue Data Base (NMDRD) publishes an annual report on positive drug residue statistics for each fiscal year and is a voluntary industry reporting program. Mandatory reporting is required by state regulatory agencies under NCIMS. Data are reported on the extent of the national testing activities, the analytical methods used, the kind and extent of the animal drug residues identified, and the amount of contaminated milk, including whether it was disposed of properly for non-human use<sup>15</sup>. Statistics show a decrease in positive samples for both bulk milk pick-up tankers and individual producer samples between the fiscal year of 2000 and 2010, which illustrates the progress made thus far in preventing antibiotic residues. In the 2000 fiscal year there were over 3,500,000 bulk milk pick-up tanker samples tested for antibiotics. Of those 7 percent tested positive. For producer samples in the same fiscal year there were over 760,000 samples tested of which 14.5 percent tested positive<sup>17</sup>. Compare that to the 2010 fiscal year where 2.5 percent of bulk milk pick-up tanker samples tested positive and 7.9 percent of producer samples tested positive<sup>15</sup>. One area of interest (and potential concern) is the discrepancy between the percentage of bulk milk pick-up tankers that confirm positive and the

individual producer samples that confirm positive. The percentage of confirmed positive bulk milk pick-up tankers is more than double the percentage of confirmed positive individual producer samples. One logical explanation for this is the far greater amount of bulk milk pick-up tanker samples tested, but the other explanation is dilution. There are instances where a producer sample is confirmed positive but the same bulk milk pick-up tanker sample is none found, because the proportion of milk from the positive producer is so small compared to the other producers on the load, that the antibiotic level in the tanker is below what the FDA has determined to be the “safe level” of beta-lactam antibiotics. A safe level for human consumption is a level of a drug in milk that would be expected to have no effect in humans based on extensive scientific study and review<sup>18</sup>. Of course many argue that a safe level is a misnomer and that exposure to antibiotics at *any* level has potentially serious consequences on human health, but the reality is not all antibiotics present in a bulk milk pick-up tanker will be detected. In lieu of this fact an exceptional on-farm management system for the judicious use of antibiotics to prevent their misuse and potential drug residues is vital for further reductions in exposure to antibiotics in milk products.

### **Management Solutions for Appropriate Use of Antibiotics :**

Appropriate use of antibiotics includes intense cow management programs that ensure the health of dairy cows and prevent them from becoming ill, judicious use when cows become ill, and proper identification procedures for treated animals to avoid milking treated cows into the bulk tank causing drug residues.

### **Cow Management Strategies to lessen need for animal drugs:**

Calves and young stock should receive high quality colostrum immediately after birth to give them the necessary antibodies to protect against calf diseases. They should be segregated

from each other in a way that prevents physical contact with other calves to minimize the spread of disease should a calf become ill. Bedding should be kept clean and fresh water made available at all times, taking care it does not become contaminated with dirt or feces. Calves should also be monitored for healthy growth rates, because strong, healthy calves will not require treatment and will enter the next phase of their lives in the best condition possible.

Young, growing heifers should be fed high-quality rations and provided with comfortable stalls with clean bedding. The heifer yard should also be clean. Animals should be observed for cleanliness, body condition score, and other cow comfort indicators such as hock lesions. Ill animals must be segregated immediately to avoid spreading an illness or disease to other heifers.

Fresh cows, which are cows that have recently given birth, are particularly vulnerable to illness at the time of calving and for several weeks post-calving. Highly nutritious pre-fresh rations should be offered to cows for several weeks prior to calving and immediately after. Fresh cows are particularly prone to metabolic disorders such as milk fever and ketosis due to the negative energy balance that occurs in the month or two post-calving. It is important to recognize the symptoms of these disorders quickly and treat cows appropriately when they occur.

As cows progress through their lactations they should continue to be closely monitored, provided with high-quality rations, comfortable stalls with clean bedding, and clean alleyways. They should be monitored for body condition score and for any potential abnormalities that may require attention. Signs of mastitis, for example, are udder quarters that are swollen and hot to the touch, sometimes with milk clots evident when the teat is stripped. These cows may need to be treated with antibiotics to clear the infection. Adequate udder preparation before the milking cups are placed on the teats is also crucial to prevent mastitis and produce a quality product. The very act of milking forces the teat canal open and it remains open after milking for as much as a

few hours. This leaves the teat vulnerable to infection from bacteria present in the alleys and stalls. Proper teat sanitization before and after milking will help reduce the risk of infection.

Most dairy producers use iodine for this purpose.

Proper dry-cow management will ensure cows enter their lactations strong and healthy. Most dairy producers use a dry-cow treatment, which is an antibiotic specifically used for non-lactating cows to keep the udder healthy and free from infection. When the cow calves she will enter the milking herd healthy and free from infection and disease. Dry-cows do not have the energy demands of a lactating cow, but should nonetheless be fed a high-quality ration to keep body condition scores acceptable and the cows in an overall state of good health.

#### When Antibiotics Become Necessary:

Even with exceptional cow management programs, it will likely be necessary to treat cows with antibiotics for disease or illness. Judicious use of antibiotics will help mitigate the negative impacts of antibiotic use for dairy consumers. Restricting all extra-label use of antibiotics except under the supervision of the farm veterinarian—with enforcement programs in place for noncompliance—would be a positive step to reaching a balance between food safety and the reality that exists in the dairy industry that necessitates antibiotic use. The FDA has issued draft guidance on the use of antibiotics and has issued the following recommendations<sup>19</sup>:

- The use of medically important antimicrobial drugs in food-producing animals should be limited to those uses that are considered necessary for assuring animal health.
- The use of medically important antimicrobial drugs in food-producing animals should be limited to those uses that include veterinary oversight or consultation.

Such limitations would reduce overall medically important antimicrobial drug use levels, thereby reducing antimicrobial resistance selection pressure, while still maintaining the availability of

these drugs for appropriate use<sup>19</sup>. Additionally, congress has introduced a bill called The Preservation of Antibiotics for Medical Treatment Act (PAMTA), H.R. 1549/S. 619 that would prohibit the nontherapeutic feeding of medically-important antibiotics to livestock, and withdraw FDA approval of antibiotics for nontherapeutic use unless the drug manufacturer demonstrates with reasonable certainty that the use of the drug will not harm human health due to antibiotic resistance. It would not, however, restrict the use of antibiotics to treat sick animals and leave other classes of drugs not used in human medicine available without restriction<sup>20</sup>.

#### Avoiding Drug Residues Through Animal Identification:

A majority of drug residues occur through the inadvertent milking of a treated cow into the bulk tank. Proper animal identification programs and records are crucial to preventing this occurrence. A leg band placed on at least two legs of the cow (so should one fall off the cow can still be identified), in a color that the dairy producer has made clear indicates a treated cow, is necessary to identify treated animals. Body chalk can also be used but it has a tendency to rub off with time. Segregating treated animals to their own milking group can also aid in animal identification. Policies should also be put in place to determine the sequence of events should a farm worker accidentally milk a treated cow into the tank. Often employees realize they have made a mistake but are reluctant to report it to the herd manager or owner due to potential repercussions. Employees must realize it is important for them to be honest when they make an error like this, however egregious it might be. If the dairy producer has the capability of testing the milk on the farm it can be voluntarily dumped should it be positive, which may be less costly than contaminating an entire bulk milk pick-up tanker.

In addition to proper animal identification protocols, there are additional tools to assist dairy producers in keeping accurate and complete animal treatment records. Some are in paper

form, which would include information like animal ID, treatment used, withholding time, and other pertinent information. There is also electronic software available to track antibiotic use on dairy farms. This enables the dairy producer to enter the appropriate information with regards to treatment schedules and protocols and can even inform farm staff of various events such as when the ill cow was moved to the “hospital” area, how long she has been in treatment, and other useful information. Maintaining complete and accurate records is essential for not only the judicious use of antibiotics, but can also be extremely helpful in legal proceedings should an issue ever occur<sup>21</sup>.

### **Conclusions:**

Antibiotics have been widely used in human and veterinary medicine for more than 50 years, with tremendous benefits to both human and animal health. The development of resistance to this important class of drugs, and the resulting loss of their effectiveness as antimicrobial therapies, poses a serious public health threat, as does exposure of antibiotics to those individuals with antibiotic allergies or sensitivities. Misuse and overuse of antibiotics creates selective evolutionary pressure that enables antibiotic resistant bacteria to increase in numbers more rapidly than susceptible bacteria and thus increases the opportunity for individuals to become infected by resistant bacteria. Because antibiotic use contributes to the emergence of drug resistant organisms, these important drugs must be used appropriately in both animal and human medicine to slow the development of resistance. Judicious use of antibiotics on dairy farms can help mitigate the effects of bacterial resistance and ensure drug residues do not appear in the milk supply. This is especially important as dairy farms increase in size and animal density increases, making cows more susceptible to diseases. Meticulous record keeping, and only using animal drugs extra-label under the direction of a veterinarian, are both crucial to minimizing the

public health risks associated with drug residues and misuse. Intense management practices at the cow level are crucial to aid in this effort. The FDA, testing laboratories, and milk plants are doing their part by issuing guidance and regulations, enforcing compliance, and testing samples to ensure the safety of fluid milk. Through cooperation and collaboration the public health implications of drug residues and misuse can be minimized, and dairy producers can continue to use antibiotics in responsible ways to treat diseased cows.

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