Why We Should Reduce Antibiotic Usage and Ways to Do It

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Introduction

Since the discovery of penicillin by Sir Alexander Fleming in the 1920s, antibiotics have played an enormous role in man’s quest for a better and longer life. Today these products are still extremely important for the wellbeing of both humans and animals, and for that reason everything that can alter their efficacy is closely scrutinized. Antibiotics are used in swine production with various objectives in mind. This paper will briefly touch on reasons why we should try to limit their usage whenever possible, and on how we can do it.

Why We Should Reduce Antibiotic Usage

For some time now the use of antibiotics in animals, particularly food producing animals, has been a hot topic. The main concern behind these discussions is that if antibiotics are used a lot in animals, veterinary pathogens or commensals may become more resistant to antimicrobials, and if so, could transfer that resistance to human pathogens. The extent to which resistance in human pathogens could be associated with antibiotic usage in animals remains an open question, the same is true for the impact that restricting access to antibiotics could have on animal health, economic performance and welfare. This being said there seems to be little doubt that pressure to reduce antibiotic usage in animals will grow, and we certainly have had examples of that pressure recently in North America. In March 2012 a poll involving 1000 US residents revealed that 72% of consumers were extremely, or very concerned, about overuse of antibiotics in animal feed and 60% were ready to pay five cents or more per lb for meat from animals raised without antibiotics (Moreno, 2012). On April 6, 2012, the US Food and Drug Administration’s ban prohibiting the use of cephalosporins at unapproved doses, frequencies, duration or routes of administration, and perhaps more importantly, for disease prevention, became effective (US Food and Drug Administration,
In June 2012, an editorial in the Canadian Medical Association Journal was titled ‘Farm-grown superbugs: While the world acts, Canada dawdles’ (Sibbald, 2012). The editorial asked for stricter regulations on antibiotic use in animals in Canada, particularly for classes of antibiotics which are of primary importance in human medicine. There is little doubt that the pressure from the human medical side for tighter controls and reduced usage of antibiotics in animals will increase. This is particularly true when efforts made elsewhere have proven that it was possible to raise pigs with less antibiotics.

The concerns over the potential impact that antibiotic usage in animals may have on human pathogens is only one aspect to consider. Animals also get sick and have to be treated and for that effective antibiotics are needed. Since it is believed that the introduction of new antibiotic molecules for use in animals is likely to be very limited in the future, we need to make sure that those we have today remain effective on a long term basis. In 1994, 99.6, 77 and 23% of the Quebec Actinobacillus pleuropneumoniae strains were sensitive, respectively, to ceftiofur, ampicillin and tetracycline (Nadeau, 2000). In 2010, only 16 years later, these percentages had dropped to 96, 55 and 0% (Nadeau, 2011). Swine are no exception, on the poultry side 97.5% of the Escherichia coli isolates were sensitive to ceftiofur in 1994, against only 57% in 2010 (Nadeau, 2000 and 2011).

Where Do Canada and North America Stand?

Before we get into ways that can be used to reduce antibiotic usage, it appears logical to look at where we, in North America, stand. In other words, are we using less, the same or more antibiotics in Canada, the US and Mexico than countries like Denmark for example, where special efforts towards antibiotic usage reduction have been made for many years? At the 2010 International Pig Veterinary Society meeting in Vancouver, Danish authors reported that between 2004 and 2009, the total quantity of antibiotics used in Danish pigs varied between 3.54 and 4.03 gr per pig (Stege, 2010). This way to calculate antibiotic consumption has recognized weaknesses, but has the advantage of being easy to understand. Because no such data were seemingly available in North America, in the summer of 2011, I tried to compile numbers on antibiotic usage in a few herds or companies in Canada, the US and Mexico, that I thought were representative of the North American industry. Since this evaluation involved a very small number of farms and had no scientific pretentions at all, the numbers will not be mentioned here, but they suggested that while not worse than in the US and Mexico, the situation in Canada can be improved. Of course the total quantity of antibiotic used in pigs and other animals is only one parameter to evaluate. The type of antibiotic used is another very important one. As we will see later, chlortetrayclline does not have the same relative importance as fluoroquinolones or third and fourth generation cephalosporins. Nevertheless, an important point can already be made at this stage: We need to know how
much of the various antibiotics we are using in pig production in Canada. We need scientifically sound data that will allow us to accurately know where we currently stand. With this in hand not only can we compare ourselves with other countries, but we can also determine if the actions we will eventually take are producing results or not. Putting that aside, let us assume that we can do better, and the rest of this document will look at some of the ways that can be used to reduce antibiotic usage in swine production.

**What Have Other Countries Done?**

A logical approach seems to be looking at what other countries have already done to reduce antibiotic usage in animals. We will use Denmark and The Netherlands as examples. Efforts to reduce antibiotic usage in animals in Denmark have been the topic of many articles and discussions, some being very positive, others suggesting that their strategy has actually not improved their consumption much over the years. Where does truth actually lie? Figure 1 shows the antimicrobial consumption in Danish pork production from 1992 to 2008. Antimicrobial consumption is defined as the number of milligrams of active compound per kilogram of pig produced (Aarestrup, 2010). As can be seen, more antibiotics were used for growth promotion than for therapeutic use in 1992. Various measures were taken to phase out growth promotion use of antimicrobials and in 2000, antimicrobials were not used anymore for that purpose. This did create an increase in the therapeutic use of these products, but the end result is still that by 2008, the Danish pig production was using less than 50% of the total they were using in 1992. Nevertheless, as the antimicrobial consumption was steadily increasing after 2000, they decided in 2010 to put in place some additional measures to stop and hopefully reverse that trend. Since then, if a producer uses two times or more the average quantity of antimicrobials used by Danish producers, he/she receives a yellow card. The producer then has 9 months, working with his or her herd veterinarian, to correct the situation. If this does not work, another veterinarian gets involved in the farm, and if this still does not produce the desired results after 5 months, other measures are discussed but not currently implemented. One of the potential measures would be a decrease of animal inventory until antimicrobial consumption goals are met. The yellow card system was initiated in the first quarter of 2010, and the Danish figures are showing an impressive decrease of 19% in pig antimicrobial consumption in 2011 (News, 2012). While this may not be totally due to the new system, the results are very encouraging.

In 2009 a plan was instituted in the Netherlands to reduce antibiotic usage in animals by 20% in 2011, and by 50% in 2013. If the objectives were not reached one of the measures considered was for veterinarians to lose the right to sell drugs. Veterinary prescriptions are mandatorily declared to public authorities through an information system called VetCis. The emphasis has been placed on biosecurity, nutritional strategies and vaccination, and
between 2009 and 2011 the total sales of antibiotics decreased by nearly 32% overall for the five livestock sectors considered (Maran report, 2012). Specifically on the swine side the number of daily dosages per sow and piglets (a different way to calculate antibiotic consumption) went from 25 daily dosages per year in 2009, to 13 in 2011, and from 16 to 8 daily dosages per year in finishing pigs.

**Figure 1. Therapeutic (RX) and growth promotion (AGP) antimicrobial consumption (mg antibiotics per kg of pig) in Danish pigs from 1992 to 2008.**

On a country basis, there are thus collective measures, guidelines or laws that have been used successfully to reduce antimicrobial usage in animals. But what about what producers and veterinarians can do in individual farms? Many different ways and alternatives can be considered, and the rest of this paper will briefly describe some of them.

### Ways to Reduce Antibiotic Usage in Swine Production

**Health Improvement and Maintenance**

The most effective way to reduce antibiotic usage in pigs is to improve their health status, and maintain it at that improved level. Of course this is not always easy, but the example I will use for this particular point is, in my opinion, quite impressive. Five different pathogens (toxigenic *Pasteurella multocida*, *Sarcoptes scabiei*, *Mycoplasma hyopneumoniae*, *Actinobacillus pleuropneumoniae* and PRRS virus) were eliminated from a small pure bred herd of 100 sows selling replacement gilts and boars (Desrosiers, 2001). Dr Réal Boutin implemented a program based on early weaning (oldest pigs were 10 days old), vaccination (for Mycoplasma, APP, toxigenic *Pasteurella* and PRRS) and medication (doramectin, ceftiofur, lincomycin and tiamulin). Since the buildings were old and would have needed major repairs anyway, it was decided to build a new farrow-to-finish barn on the same site, about 75 meters from the existing facilities that would receive the 'clean' piglets weaned within the program. Following a strict biosecurity protocol, these piglets would
then be raised without any direct or indirect contact with the infected population, and become the new sows and boars of that herd. The reason why the owner opted to try such a complicated and risky program is because genetics in his herd were of great value, and he wanted to preserve that. The program was a success, and all 5 organisms were eliminated from the herd. **Table 1** shows the lesions in pigs from that herd before and after the program, for periods of 6 months each. As can be seen, the picture was dramatically changed. The first clean piglets were produced in January 1999. Ten years later the lesions were still at very low levels. The same spectacular results were obtained as far as antibiotics usage is concerned. Before the program the approximate quantity of antibiotics used in the feed was about 80 g/pig, while no antibiotics at all were used in the feed, or in the water, after completion of the program. After the program the mortality in that herd was about 2.5% from weaning to slaughter. It should be mentioned that the herd is not located in a hog dense area, and is 4 km away from the next pigs. One might say that such health improvement programs are limited to farms located in areas with few pigs, but there are herds in France located in very hog dense areas that have maintained a high health status over many years. These are farms using HEPA air filtration with positive pressure. While this particular air filtration system is very expensive, cheaper alternatives have been developed, and hopefully the search for effective and even cheaper systems will continue.

**Table 1. Respiratory and liver lesions for periods of 6 months before and after the program.**

<table>
<thead>
<tr>
<th>Lesions</th>
<th>Before the program (%)</th>
<th>After the program (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk spots on liver</td>
<td>32</td>
<td>1</td>
</tr>
<tr>
<td>Cranioventral lesions &lt; 10 %</td>
<td>54</td>
<td>4</td>
</tr>
<tr>
<td>Cranioventral lesions &gt; 10 %</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Pleuritis less than 6 inches</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>Pleuritis more than 6 inches</td>
<td>8</td>
<td>1</td>
</tr>
</tbody>
</table>

**Management**

A 250-sow herd produces 25 kg pigs that are raised in two different finishing sites. On the first site the small 500-place capacity building (Barn A) is filled in one month, but usually emptied before the next batch of pigs is introduced, so it is an all-out system by building. On the second site the barn is too big (2000 places; Barn B) to be run all in – all out by building with such a small source of piglets, so pigs are introduced every week in an all in – all out system by room. **Table 2** shows the results in these two finishing units in terms of lung...
lesions at slaughter, mortality and need for added medication (Miclette J, personal communication, 2011). The results obtained are all in favor of Barn A, for which no antibiotic supplementation is necessary. A diagnostic investigation revealed that PRRS virus was circulating in Barn B, but not in Barn A. Since Barn B is never emptied, viral circulation is maintained even though the sow herd supplying the piglets produces PRRS-negative pigs. Similarly the levels of cranioventral lung lesions in Barn A and in Barn B strongly suggest that *Mycoplasma hyopneumoniae* is circulating in Barn B, but not in Barn A. In essence, different ways of managing the same pigs produce different results in terms of health status and in terms of need for antibiotic supplementation.

Table 2. Lung lesions, mortality and feed antibiotic usage in two finishing units receiving the same piglets and the same feed.

<table>
<thead>
<tr>
<th></th>
<th>January to April 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Barn A</td>
</tr>
<tr>
<td># lungs examined</td>
<td>322</td>
</tr>
<tr>
<td>Cranioventral lesions &lt; 10%</td>
<td>1%</td>
</tr>
<tr>
<td>Cranioventral lesions &gt; 10%</td>
<td>0%</td>
</tr>
<tr>
<td>Mortality</td>
<td>~3%</td>
</tr>
<tr>
<td>Antibiotic supplementation needed</td>
<td>No</td>
</tr>
</tbody>
</table>

**Environment**

A system includes three sow herds, a large nursery site with seven buildings and six different finishing sites. Piglets from the three sow herds are mixed in the nursery, and then transferred into the finishing units at about 25 kg. An all in – all out system by building is used in all the barns on all finishing sites. These finishing sites, which include 14 different buildings, all receive the same piglets, the same feed and preventive medication, and overall have the same health management program. Five of the different finishing sites, involving 11 units, never had a clinical diagnosis of ileitis, and thus no treatment for that disease has ever been necessary in these sites. The sixth site has 3 buildings of 540, 840 and 1200 pigs respectively. No clinical ileitis diagnosis has been made in the smallest unit so far. The mid-size unit had a few cases involving a low number of animals, but the largest one had significant ileitis cases that had to be treated in each of the last three batches of pigs that were introduced in that building (Brochu J, personal communication, 2011). Since the same pigs receiving the same feed and medication programs are repeatedly raised elsewhere without problems, one can only conclude that something in the
environment of that site, and particularly in the largest barn, makes pigs more likely to develop ileitis. Although washing and disinfection of that barn between batches appear to be adequate, there is obviously a possibility that infection pressure for *Lawsonia intracellularis* may be greater in that barn. Rodents can be carriers of that organism and could potentially be the source of that persistent problem, but a professional rodent control program has been in place for years on that farm and signs of rodent infestation are certainly not obvious. It has recently been demonstrated that insects like flies can be carriers of LI, so this is something that may have to be evaluated (McOrist, 2010). The large barn also is using water from a different well than the other two barns on the site. While the investigation is going on, the end result remains the same: something in the environment of that site makes pigs more likely to get ileitis, and to be treated with antibiotics.

**Weaning Age**

This one is quite straightforward. Alban et al (2010) reported that in Denmark antibiotic consumption in weaner pigs was 6,692 kg for respiratory conditions, and 23,840 kg for enteric conditions. So, more than three times the quantity of antibiotics is used to control diarrhea than used to control respiratory diseases. The younger the weaning age, the more likely pigs are to develop diarrhea post-weaning. In that respect weaning pigs at an older age is clearly a way to reduce the need for antibiotics. In a paper presented at the 2012 AASV meeting and involving a challenge with an F18 strain of *Escherichia coli* at 26 days of age, piglets weaned at 16 days developed diarrhea earlier and more severely than pigs weaned at 20 days of age (McLamb, 2012). Furthermore, gain reduction was much more pronounced in pigs weaned at 16 days of age (89%) compared to those weaned at 20 days (18%). Finally, weaning older and heavier pigs can not only have a benefit in terms of antibiotic usage, but also in terms of performance.

**Feed and Water Ingredients**

There is a multitude of papers reporting the positive impact of various feed and water ingredients as alternatives to antibiotics. In one of them, Evelsizer et al (2010) used essential oregano oil to prevent problems associated with what we were calling hemorrhagic bowel syndrome, and/or intestinal torsions. For 14,090 control pigs the mortality associated with these problems, which are often prevented using low to moderate antibiotic levels, was 1.29%, while it was only 0.16% for 17,923 pigs receiving the oregano based product. Buddle (2002) has suggested that hemorrhagic bowel syndrome and intestinal torsions were different manifestations of the same condition, and proposed a different name: porcine intestinal distension syndrome.
Season

The Iowa State University Veterinary Diagnostic Laboratory maintains data of the various diagnostics made each year. In an 8 year compilation (2003-2010) of enzootic pneumonia diagnostics, it was found that the number in September-October was close to 3 times what it is between February and June (Schwartz K, personal communication, 2011). This suggests that there are situations where instead of using antibiotics year round to control that condition, there may be opportunities to design antibiotic programs according to the relative seasonal risk. In other words, a reduced antibiotic usage in periods of reduced risks.

Genetics

In my opinion this is an area where we are likely to make significant progress in the coming years. In an evaluation conducted in Denmark, 12 Duroc boars, 700 sow and 12,268 pigs were used. The pigs from the different boars were born and raised in the same 3 farrow to finish farms that had been selected because they had respiratory disease problems (Nielsen, 2006). It was found that in the nursery phase, one of the boars produced piglets that had a mortality rate of 3% while it was 10% for another one. Similarly, in the finishing phase one boar produced pigs with a mortality of 2% while another one had a 10% mortality in its progeny. The mortality differences between boars were highly significant (P < 0.002, nursery; P < 0.0007, finishing). Differences between the progeny of boars were also found in pleuritis (44% for the best and 68% for the worst, P < 0.0001) and pneumonia (18% for the best and 57% for the worst, P < 0.0001). These results, where pigs from different boars were raised side by side in the same environment clearly indicate that some boars produce pigs that have a better survivability and resistance to disease than others. Using such genitors would evidently increase the possibilities of raising pigs with reduced dependence on antibiotics.

Gender

Pommier et al (2008) found differences between genders in the percentage of lungs with pleuritis (9.1% for females, 11.0% for males; p = 0.02) and pneumonia (54.4% for females and 61.9% for males; p < 0.001) at slaughter. In a study involving 6 finishing units and 7,982 pigs, 68% of the pigs that died were males and 32% were females (Surprenant C, personal communication, 2011). In another study involving close to half a million pigs, mortality in gilts receiving no antibiotics was at 4.26%, while it was 6.41% for barrows receiving antibiotics (Moreau, 2001). Since females are less sick and survive better than males, raising them separately increases the possibilities of reduced antibiotic usage for at least half the production. Furthermore, due to the difference in top quality pigs and feed cost savings, there was an advantage of $4.22 per pig when barrows and gilts were raised separately, compared to raised together (Jungst et al., 2012).
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Parity Segregation

Parity segregation means that piglets born from gilts are raised separately from piglets born from sows of other parities. Piglets born from gilts are more susceptible to different conditions and may thus require more aggressive preventive control programs. For example, in a company where parity segregation was used, piglets from gilts were vaccinated against enzootic pneumonia, injected with tulathromycin at weaning and chlortetracycline was added to their feed on weeks 1, 4 and 7 after placement in finishing units. Piglets born from other parities were not vaccinated against enzootic pneumonia, were not for the most part injected with tulathromycin at weaning and chlortetracycline was added to their feed only on week 1 post placement in finishing units (Cardinal F, personal communication, 2011). Parity segregation may thus reduce antibiotic usage for about 75% of pigs produced.

Individual Treatments

One of the reasons why Denmark is able to produce pigs with less antibiotics than many other countries is that they rely much less on treatment of the whole population than we do for example in North America. They will treat individual pigs, or pens, but generally not the whole group of pigs. In some situations, treating individual pigs has been shown to produce better results, at lower costs than treating all the animals in the feed or water. Table 3 shows the results that were obtained in a Quebec company where pigs affected with porcine pleuropneumonia were either treated individually by injection, or the total group was treated in the feed and/or water (Desrosiers, 1986). Not only were the results obtained clearly better with individual treatments, but the antibiotic cost associated with it was also much lower. It should be mentioned that when this study was conducted, the choice of antibiotics that could be used in the feed or water was more limited than it is today. Nevertheless, particularly for acute conditions like porcine pleuropneumonia, which reduce feed and water consumption of affected animals, injection of sick pigs is often more cost effective than oral treatment of the whole group.

Table 3. Comparative results of pigs that were affected with porcine pleuropneumonia and treated either by oral medication in the feed and/or water, individually by injection, or not affected with the condition.

<table>
<thead>
<tr>
<th></th>
<th># units</th>
<th># pigs</th>
<th>% mortality</th>
<th>Drug cost, $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral</td>
<td>3</td>
<td>3,613</td>
<td>11.4</td>
<td>4.79</td>
</tr>
<tr>
<td>Injection</td>
<td>35</td>
<td>46,059</td>
<td>2.34</td>
<td>3.03</td>
</tr>
<tr>
<td>Controls</td>
<td>62</td>
<td>84,599</td>
<td>1.92</td>
<td>1.97</td>
</tr>
</tbody>
</table>
Vaccines

Obviously using vaccines to prevent disease rather than antibiotics is an easy way to reduce antibiotic usage. In a Danish study on 20 farms, those using a live \textit{Lawsonia intracellularis} vaccine used less antibiotics than those that did not (11.4 ADD per 100 weaned pigs vs. 14.8) (Bundgaard, 2012).

Other Options

There are other options to reduce antibiotic usage in swine production. Improving biosecurity in a way that allows reducing the introduction of new pathogens or strains in a given herd is an obvious one, the PRRS virus being an easy example of that. Producers have a tendency to think that if a little is good, more is better, and there are cases where the dosage used to treat a condition is much higher than necessary. Some antibiotics can be effective at dosages (mgs of antibiotic per kg of pig) that are a lot lower than others, so switching to these products automatically reduces the grams of antibiotics per pig, but other issues need to be considered. Using pulse treatments rather than continuous medication can not only reduce the total dosage of antibiotics used, but may also allow the pig to mount an immune response to the organism targeted. In a recent study electrostatic particle ionization was shown to significantly improve air quality, gain and mortality of nursery pigs and thus may reduce antibiotic usage by allowing raising healthier pigs (Rademacher, 2012). The options described in this paper are not inclusive, and we should keep an open mind to any product, strategy or technique that has the potential to reduce antibiotic usage in our production.

- **Choice of Antibiotic Used**

Antibiotic usage \textit{per se} is only one aspect of the problem. The choice of antibiotic used is another important one. Some antibiotics are considered as the last resort therapeutic compounds against certain human and swine diseases and it is of paramount importance to make sure that these antibiotics remain effective on a long term basis. This is particularly true when considering that access to new antibiotics is, as mentioned before, likely to be rather limited in the future. For that reason, their usage should be limited to situations where they are really necessary. The Canadian Veterinary Medical Association produced a document in which it categorized the various antibiotics available according to their strategic importance in human medicine (Agriculture and Agri-Food Canada, 2008; \textbf{Table 4}).
Table 4. Categorization according to their relative importance in humans of antibiotics that can be used in swine.

<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Very high importance</td>
<td>Cephalosporins (third &amp; fourth generations) fluoroquinolones; penicillins – lactamase inhibitor combinations; polymixins; streptogramins</td>
</tr>
<tr>
<td>2</td>
<td>High importance</td>
<td>Aminoglycosides; lincosamides; macrolides; penicillins; trimethoprim-sulfamethoxazole</td>
</tr>
<tr>
<td>3</td>
<td>Medium importance</td>
<td>Aminocyclitols; bacitracins; nitrofurans; phenicols; sulphonamides; tetracyclines</td>
</tr>
<tr>
<td>4</td>
<td>Low importance</td>
<td>Flavophospholipols; ionophores</td>
</tr>
</tbody>
</table>

**Conclusion**

To what extent antibiotic usage in animals is responsible for developing resistance of human pathogens to some key antimicrobial molecules remains a topic of vivid discussions. Some say it is of marginal importance, others state that it is significant and that it would be irresponsible not to address it, but which side serves us better? Putting energy, time and money trying to prove that the use we make of antibiotics in animals is ‘not that bad’, or changing our ways so that the human medical authorities appreciate the effort we make to address the issue and eventually become more collaborative and conciliatory with livestock producers and animal health professionals? Independently of pressures from the human side, we need to keep in mind that increasing antibiotic resistance to swine pathogens is also a concern. Pigs can get sick, and when they do, they need to be effectively treated and this will be compromised if antibiotic resistance to important pathogens continues to increase. Finally, producing pigs that are raised with less antibiotic usage is something that could be used as a comparative advantage, when comes time to offer Canadian pork to local and export markets. A limited and judicious use of antibiotics in swine production would thus seem to be in the best interest of all those involved in our industry.

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