

# Managing Antimicrobial Resistance in Food Production: Conflicts of interest and politics in the development of public health policy

Bryn Williams-Jones et Béatrice Doizé

Volume 5, numéro 1, printemps 2010

URI : <https://id.erudit.org/iderudit/1044423ar>

DOI : <https://doi.org/10.7202/1044423ar>

[Aller au sommaire du numéro](#)

Éditeur(s)

Centre de recherche en éthique de l'Université de Montréal

ISSN

1718-9977 (numérique)

[Découvrir la revue](#)

Citer cet article

Williams-Jones, B. & Doizé, B. (2010). Managing Antimicrobial Resistance in Food Production: Conflicts of interest and politics in the development of public health policy. *Les ateliers de l'éthique / The Ethics Forum*, 5(1), 156–169. <https://doi.org/10.7202/1044423ar>

Résumé de l'article

La surutilisation et l'utilisation inappropriée d'antimicrobiens chez les humains et en agriculture ont accentué le phénomène de développement de résistance aux antimicrobiens par de nombreux agents pathogènes. Cette situation cause un important problème de santé publique. Bien que les autorités agricoles et de santé publique reconnaissent l'ampleur du problème, elles éprouvent néanmoins une grande difficulté à traduire les recommandations en lignes directrices applicables. Au cours de cet essai, nous examinons le processus de développement des politiques de santé publique en agriculture au Québec, en mettant l'accent sur le cas de la production porcine et le rôle des vétérinaires dans l'élaboration de ces politiques. Nous sommes d'avis que la tendance technoscientifique d'utilisation des analyses de risques des antimicrobiens ne tient pas compte des intérêts fondamentaux, soit sociaux, économiques et politiques, des parties prenantes principales. Elle limite ainsi l'applicabilité des recommandations des politiques publiques développées par des groupes consultatifs. En particulier, nous suggérons que les intérêts personnels et professionnels des vétérinaires, ainsi que leurs normes éthiques, sont à la fois les facteurs principaux du problème, et la solution à la dépendance excessive aux antimicrobiens dans la production alimentaire.

Tous droits réservés © Centre de recherche en éthique de l'Université de Montréal, 2010



Ce document est protégé par la loi sur le droit d'auteur. L'utilisation des services d'Érudit (y compris la reproduction) est assujettie à sa politique d'utilisation que vous pouvez consulter en ligne.

<https://apropos.erudit.org/fr/usagers/politique-dutilisation/>

éru  
dit

Cet article est diffusé et préservé par Érudit.

Érudit est un consortium interuniversitaire sans but lucratif composé de l'Université de Montréal, l'Université Laval et l'Université du Québec à Montréal. Il a pour mission la promotion et la valorisation de la recherche.

<https://www.erudit.org/fr/>

MANAGING ANTIMICROBIAL  
RESISTANCE IN FOOD PRODUCTION:  
CONFLICTS OF INTEREST AND  
POLITICS IN THE DEVELOPMENT OF  
PUBLIC HEALTH POLICY

BRYN WILLIAMS-JONES ET  
BÉATRICE DOIZÉ  
UNIVERSITÉ DE MONTRÉAL

## ABSTRACT

Antimicrobial resistance is a growing public health concern and is associated with the over- or inappropriate use of antimicrobials in both humans and agriculture. While there has been recognition of this problem on the part of agricultural and public health authorities, there has nonetheless been significant difficulty in translating policy recommendations into practical guidelines. In this paper, we examine the process of public health policy development in Quebec agriculture, with a focus on the case of pork production and the role of food animal veterinarians in policy making. We argue that a tendency to employ strictly techno-scientific risk analyses of antimicrobial use ignores the fundamental social, economic and political realities of key stakeholders and so limits the applicability of policy recommendations developed by government advisory groups. In particular, we suggest that veterinarians' personal and professional interests, and their ethical norms of practice, are key factors to both the problem of and the solution to the current over-reliance on antimicrobials in food production.

## RÉSUMÉ

La surutilisation et l'utilisation inappropriée d'antimicrobiens chez les humains et en agriculture ont accentué le phénomène de développement de résistance aux antimicrobiens par de nombreux agents pathogènes. Cette situation cause un important problème de santé publique. Bien que les autorités agricoles et de santé publique reconnaissent l'ampleur du problème, elles éprouvent néanmoins une grande difficulté à traduire les recommandations en lignes directrices applicables. Au cours de cet essai, nous examinons le processus de développement des politiques de santé publique en agriculture au Québec, en mettant l'accent sur le cas de la production porcine et le rôle des vétérinaires dans l'élaboration de ces politiques. Nous sommes d'avis que la tendance technoscientifique d'utilisation des analyses de risques des antimicrobiens ne tient pas compte des intérêts fondamentaux, soit sociaux, économiques et politiques, des parties prenantes principales. Elle limite ainsi l'applicabilité des recommandations des politiques publiques développées par des groupes consultatifs. En particulier, nous suggérons que les intérêts personnels et professionnels des vétérinaires, ainsi que leurs normes éthiques, sont à la fois les facteurs principaux du problème, et la solution à la dépendance excessive aux antimicrobiens dans la production alimentaire.

## INTRODUCTION

A series of food safety scares and crises in North America and Europe are arguably at the origin of a loss of public confidence in the safety of foods and in government food safety policy-making. Notable recent examples include outbreaks of salmonella or *E. coli* contamination in vegetables and processed meats in the United States and Canada, public debates in Europe about the integration of hormones or genetically modified foods into food production, the spread of Foot and Mouth Disease (FMD) in cattle in the United Kingdom and Canada, and the discovery in 2008 of Listeriosis contaminated cheese in Quebec. These events have left many people with the impression that things “are out of control”, raising concerns not only about food safety, but also about government accountability and transparency. Less clear, however, are the reasons for this apparent lack of accountability or the means by which to improve the situation. As we will argue in this paper, it is critical to attend to the social, economic and political dimensions of agriculture (e.g., economies of scale, vertical production integration, international trade, cheap and ready access to quality food products) and the associated diverse and potentially conflicting interests of key stakeholders, most notably food animal veterinarians, farmers/producers, the pharmaceutical industry, and the general public. Only with such an understanding, we suggest, is it possible to comprehend historical and contemporary government responses to food and public health crises, and be able to positively influence future agricultural and public health policies.

Perhaps the most dramatic case of food contamination was the outbreak, in the 1990s, of Bovine Spongiform Encephalopathy (BSE) or “Mad Cow disease” in sheep and cattle in the United Kingdom. This disease occurs naturally although infrequently in ruminants, and was spread through the common agricultural practice of using bone meal in animal feed, some of which had originated from infected animals; bone meal is an excellent source of supplemental protein, calcium and phosphorous and suitable for use in feeding hogs, chickens and ruminants.<sup>1</sup> The great concern about the BSE outbreak was the discovery of a link between this animal disease and the development of variant Creutzfeldt-Jakob Disease (vCJD) in humans, a fatal neurological disease that has proven impossible to treat and exceedingly hard to contain. Over the ensuing decade, recognition of the link between BSE and vCJD lead many countries to change their agricul-

tural practices regarding the composition of animal feed (e.g., prohibitions on the use of bone meal), to introduce more stringent monitoring of food animals (e.g., tracking animals by farm of origin, age, disease-free status), and to initiate restrictive blood donation criteria for public and private blood banks (e.g., in Quebec, people who had lived in the UK or Western European countries considered at high risk for vCJD are prohibited from donating blood<sup>2</sup>).

While the UK and international responses to BSE (and the threat of vCJD) may seem appropriate, studies examining the emergence of BSE in the UK and the actions taken by UK agricultural and health authorities reported serious problems with transparency in the risk assessment process, a lack of communication within and between government departments, and an administrative culture that did not promote accountability.<sup>3</sup> For example, concern to not destabilize public perception about the safety of the meat production system lead officials to de-emphasize possible risk factors for spreading BSE or acquiring vCJD. A decade later, the outbreak of FMD in the UK raised similar issues about public health policy making. Foot and Mouth was an economic disease, and an economic disaster for farmers and communities. Pressure from government to eradicate the disease through the massive slaughter of animals (over six million) was motivated almost entirely by trade and economic considerations, and not the danger posed for human health or that of livestock. The UK Ministry of Agriculture, Fisheries and Food (MAFF) claimed that a mass slaughter was the only way to contain the spread of the disease, despite the ready availability of a vaccine. Vaccination was not considered an acceptable option because of concerns about what the use of a vaccine would imply about Britain’s “disease-free” status and its negative impact on international trade.<sup>4</sup> The MAFF was influenced by value assumptions about productivity levels, a limited conception of animal welfare, and a presumption that economic interests would be affected if the disease was not eradicated rapidly. There was also a lack of broad stakeholder participation concerning the issue of vaccination.<sup>5</sup>

In North America and Europe, there has been a growing and largely positive discourse amongst academics and policy makers about the utility and importance of involving various stakeholder groups in health policy making; the idea is that if diverse public voices or perspectives are “at the table”, then this will lead to better (i.e., more representative, equitable, and publicly acceptable) policy.<sup>6</sup> However,

as has been shown in recent social science research on the use of public or stakeholder participation processes in policy making (e.g., dealing with genetically modified foods, or new biomedical technologies<sup>7</sup>), one must be wary of seeing these mechanisms as a panacea for problems of accountability and trust. It is essential to recognise the political and economic interests inherent in policy making (e.g., related to food safety and international trade), and consider seriously who would be appropriate stakeholders to involve in any deliberative policy making process.

In this paper, we examine these two issues in more detail through a study of the regulatory system for food animal (and specifically pork) production in Quebec. We focus on moves by professional and government advisory groups to regulate and better manage antimicrobial drug use in pork production in order to mitigate the development of antimicrobial resistance in humans,<sup>8</sup> something that is a widely recognized and growing public health concern. Pork production is one of the leading export sectors of agri-food products in Canada (or was until the recent “porcine” H1N1 flu scare), and Quebec produces the most hogs in the country (1/3 of the total inventory of hogs in Canada<sup>9</sup>); the sector is worth billions of dollars annually to the Quebec and Canadian economies. Unlike other food production sectors, however, pork production in Quebec and the rest of Canada is substantially vertically integrated (described more fully below), so decisions about production practices and the use of antimicrobials are invariably shaped by corporate interests. Yet in contrast to most other jurisdictions in North America where antimicrobials can be purchased over the counter by food producers, in Quebec only veterinarians are permitted to prescribe antimicrobials. But because veterinarians are paid by food producers for their services (and may also generate revenues from prescribing and even selling pharmaceuticals), and are required to protect public health (e.g., by managing/limiting the use of antimicrobials), they encounter challenging conflicts of interest both in their daily practices, and in their participation in the development of public health guidelines and policy. Food animal veterinarians are key actors (and a major stakeholder group) in pork production, the administration of antimicrobial drugs, and in the development of public policy to moderate or limit their use. In this context, we argue that veterinarians’ personal and professional interests, and their ethical norms of practice, are key factors to both the problem and the resolution of the current over-reliance on antimicrobials in food production.

## BACKGROUND

Before discussing the ethical challenges related to stakeholder and specifically veterinarian involvement in managing antimicrobial use in Quebec agriculture, it will be helpful to first examine the reasons for the current widespread use of antimicrobials in food animal production, the risks this poses for public health, and the problems it raises for agriculture and public health policy.

### *Antimicrobial use in agriculture and its public health implications*

The development of antimicrobial resistance is a major international public health concern.<sup>10</sup> Indeed, the growing prevalence of potentially fatal infectious diseases attributed to antimicrobial resistant microorganisms raises a very worrisome public health scenario, that is, the large scale spread of untreatable infectious diseases. Multidrug resistant tuberculosis (1 to 2% of the worldwide cases of TB), methicillin-resistant *Staphylococcus aureus*, and penicillin-resistant and macrolide-resistant *Streptococcus pneumoniae* are all antimicrobial resistant microorganisms that pose serious public health challenges in both developed and developing countries. Antimicrobial resistance is also emerging and spreading among food borne microorganisms such as *Campylobacter* and *Salmonella*. The problem of antimicrobial resistance has been recognized since practically the first use of antibiotic and antiviral drugs in human medicine. Yet it is only in the last few decades that the medical, scientific and public health communities have become aware that antimicrobial resistance now involves almost all genera of microorganisms associated with human and animal diseases.

The cause of this increase in prevalence of resistant microorganisms has been attributed to increasing and often inappropriate use of antimicrobials in human medicine, but also to overuse by the agricultural industries.<sup>11</sup> The major agricultural use of antimicrobial drugs is in the production of poultry, hogs and cattle, and somewhat less in aquaculture and plants. Antimicrobials are now widely used by veterinarians to treat infections (therapy), to improve growth and feed efficiency (growth promotion), for metaphylaxis (treatment of clinically healthy animals belonging to the same pen or flock, as animals with clinical symptoms) and for prophylaxis (treatment of healthy animals to prevent disease in stress periods).

The use of antimicrobials as growth promoters in food animals such as hogs began in the late 1940s and early 1950s, at a time when food production in North America and Europe was insufficient and too costly to meet growing public demand. During this period, the World Health Organisation (WHO) and Food and Agricultural Organisation (FAO) were set up by the United Nations, with as a priority the development of initiatives to increase global food supply. The ‘Green Revolution’ in agriculture was seen as a scientific and technological revolution: technical, biological and mechanical innovations – alongside substantial financial capital investments through agricultural subsidies – would enable industrialized and developing countries to both meet their growing national food needs and to participate in the expanding global agricultural market.<sup>12</sup> One such technical/biological solution was the widespread use of low concentrations of antimicrobials to stimulate food animal growth and increase the yield of meat per unit of animal feed.<sup>13</sup> Low concentrations of antimicrobials moderately inhibit the growth of microbial flora, especially the lactic flora. This results in a preservation of carbohydrates and proteins in the small intestine, decreased transit across the large intestine and bowel, an increased production of volatile fatty acids, and thus increased availability of nutrients and energy for animal growth.<sup>14</sup>

To put this issue into perspective, the amount of active ingredient consumed per hog after weaning (on average four months) is 37g in Québec, 40g in France, but only 3g in Denmark.<sup>15</sup> These differences reflect to some extent variation in the scale of industry, but arguably have more to do with scientific and policy choices about the appropriate use of antimicrobials. Given the massive scale of contemporary agricultural production in North America and Europe (e.g., the Canadian inventory of all hogs in 2006 was 15 million animals; in the US, the inventory was 61 million animals),<sup>16</sup> very large quantities of antimicrobials are being used. Of note, 50% of all antimicrobials sold around the world are now used in food animal production.<sup>17</sup> Most of these drugs are the same or very close in chemical structure to the antimicrobials used in human medicine, providing favourable conditions for selection, spread and persistence of antimicrobial resistant pathogenic and commensal bacteria<sup>18</sup> in animals. The problem for human health is that these resistant bacteria or the resistant genetic determinants (particularly when they

are multi-drug resistant) may be transmitted to humans via the food chain or by direct contact with animals.<sup>19</sup>

By the 1960s, it was already quite well recognised in the agricultural and scientific communities that the prolonged use of antimicrobials favoured the appearance of resistant microorganisms. For example, in 1969 the UK’s Swann Committee recommended restricting the low level use of therapeutic antimicrobials (i.e., antimicrobials used to treat human diseases) in animal feed.<sup>20</sup> Yet despite this recognition of the public health problems posed by antimicrobial use in food production, North American and European regulatory authorities continued to accept if not actively encourage the use of antimicrobials (e.g., in feed additives) as growth promoters and prophylactic drugs for food producing animals.<sup>21</sup> Consumers in North America and Europe had come to accept – and even demand – that food would be safe and affordable. The commercial and economic implications of the new antimicrobials as management tools (e.g., reduction in disease outbreaks, increase in food yield) were simply too attractive, and arguably one of the reasons for a general lack of concern about the development of antimicrobial resistance in food producing animals.

This failure to question the implications of widespread and often indiscriminate use of antimicrobials was further supported by the traditional strategy of the pharmaceutical industry to deal with antimicrobial resistance in the context of human health care. That is, every time resistance appeared against a particular antimicrobial drug, a new antimicrobial or class of antimicrobials would be developed and introduced into human and veterinary medicine, and into animal food production management. Unfortunately, while the first 30 years following the discovery of penicillin saw the introduction of a multitude of antimicrobials that were able to stay ahead of resistance, during the last 25 to 30 years only one new family of antimicrobials (the oxazolidinones) has been introduced. It seems that this market has lost its appeal to “Big Pharma”,<sup>22</sup> arguably because the classical response of developing a new antimicrobial or class of antimicrobials every time resistance appears has become untenable.<sup>23</sup> There is now general scientific agreement that the only viable option to limit resistance development is to decrease the selection pressure on resistant microorganisms, which entails decreasing antimicrobial use. Yet as already mentioned, modern food animal production has become dependant on the use of large quantities of antimicrobial drugs, a linkage that is no longer sustainable.



## Policy strategies to reduce antimicrobial resistance

In recent years, international guidelines concerning the use of antimicrobial drugs in food-producing animals have been developed, including for example, the *WHO Global Principles for the Containment of Antimicrobial Resistance in Animals intended for Foods* and the *OIE Guidelines on Responsible and Prudent Antimicrobial Use*.<sup>24</sup> These guidelines provide a framework of actions to take to reduce the overuse or misuse of antimicrobials in order to protect human health. They include recommendations on pre-approval, manufacturing, distribution, sales and the prudent use of drugs. They also promote resistance surveillance programs, and education of veterinarians and farmers (food producers) about the appropriate use of and dangers associated with misusing antimicrobials in food animals. Some of these policies have even gone so far as to recommend a complete ban on the use of antimicrobials as growth promoters in the absence of detailed risk assessments, if these drugs are also used in human therapy. Concerns about the need to respond to the growing public health challenge of antimicrobial resistance have also stimulated international professional and scientific conferences, including a number in Canada, and led to the development of policies and guidelines at both the national and regional levels. Unfortunately, both in Canada and internationally, there seems to be great difficulty in translating these directives into concrete, practical recommendations that acknowledge the range of interests involved, and so be acceptable to the key stakeholders such as farmers, veterinarians, and food production companies.

In October 2005, the Ontario Ministry of Agriculture Food and Rural Affairs, and the Public Health Agency of Canada, organised a conference entitled *Agriculture's role in managing antimicrobial resistance - The road to prudent use*, which was a follow-up to a similar conference held in 1999. The conference brought together many stakeholders, including research scientists, members of regulatory agencies, representatives from the pharmaceutical and food industries, members of the medical community, and food animal veterinarians. The aim was to discuss the changes in antimicrobial resistance since 1999 and to determine how to improve antimicrobial use in agriculture in Canada over the next five years. The outcomes of this meet-

ing included a series of recommendations to guide antimicrobial use: 1) the need for clinical practice guidelines on prudent antimicrobial use; 2) mandatory enrolment in On-farm Food Safety (OFFS) programs;<sup>25</sup> 3) the production and availability of national surveillance data; 4) improved education of veterinarians and food producers about antimicrobial usage and antimicrobial resistance; and 5) improved scientific knowledge. While these recommendations are certainly a positive step, they are somewhat bureaucratic in nature (a focus on quality control and participation in screening programs) and are often distant from the practical realities of the food animal veterinarians or food producers using antimicrobials. For example, while the collection of national-level data about antimicrobial use and resistance is helpful when the spread of an animal pathogen has been recognized, these data are not directly useful for the practicing veterinarian who needs information about a specific farm or production system (e.g., relative disease status, relative ages of animals, purpose of use of antimicrobials).<sup>26</sup>

An examination of reports prepared in 2002 and 2005 by Health Canada's Advisory Committee on Antimicrobials in Food Animals in Canada finds similar general statements with relatively few specifics or practical recommendations for the key stakeholders.<sup>27</sup> These reports also seem to be premised on the notion that the problems posed by antimicrobial use in food animals can be resolved primarily through the application of rigorous scientific research and a quantification of the relevant risks and benefits. That is, problems will be solved through "a risk-based decision-making approach embracing management strategies that are appropriate or proportional to the expected risks from the use of a product".<sup>28</sup> Yet there is little in the way of specification about how to arrive at the ultimate decision to use or not to use antimicrobials; veterinarians are encouraged to be "responsible and judicious" and to act according to the Canadian Veterinary Medical Association "prudent use" principles. These principles state that veterinarians should assist clients with the design of proper programs to reduce disease and antimicrobial usage; consider alternative therapeutic options, dispense and prescribe antimicrobials only within the confines of a valid veterinarian-client-patient relationship; and properly select and use antimicrobial drugs.<sup>29</sup> Finally, there is no attention to the practical challenges facing veterinarians or food produc-

ers, and in particular, the social and economic pressures that promote the very excesses in antimicrobial use that these policies seek to reduce.

In Quebec, the Ministère de l'Agriculture, Pêcheries et Alimentation du Québec (MAPAQ) is working towards a ban on the use of antimicrobials as growth promoters in hogs. To justify this eventual ban, MAPAQ commissioned a study on the use of antimicrobials in growing-finishing hogs, to be conducted by Épidémiologie Inc. (final report, December 2007<sup>30</sup>); in parallel, MAPAQ's Sous-groupe de travail sur l'antibiorésistance conducted a study on the social impact of such a ban, entitled *Evaluation de l'impact de l'interdiction de l'utilisation des antibiotiques comme facteurs de croissance*. (It should be noted that the use of antimicrobials as growth promoters is banned in the European Union, and there have already been several studies on this subject.<sup>31</sup>) While the MAPAQ studies might lead one to conclude that the Quebec government is taking into account the social and economic implications of such a prohibition and is not simply focusing on the technical or scientific considerations, the actual practice of policy development seems to reflect the more traditional technocratic approach of their provincial (e.g., Ontario) and federal counterparts. For example, the MAPAQ studies were conducted with limited transparency or public accountability. Of particular note is the fact that the list of the working-group members (which included veterinarians), and the report and recommendations of the Sous-groupe de travail sur l'antibiorésistance which were finalized in December 2006, only became available in September 2008; the reason for this delay is unknown.

In Quebec, and in Canada more generally, the subject of antimicrobial resistance in agriculture is “super sensitive”. When the issue is raised with provincial and federal policy makers, one senses an unease and a reticence to discuss the issue in detail. Policy makers hide behind claims about a “need for confidentiality” and assertions that “work is ongoing but not yet ready for public dissemination”.<sup>32</sup> Specific enquiries by interested parties into the actual policy development process – or more general queries about what should be the appropriate response to preventing antimicrobial resistance – are arguably perceived as a threat by those involved. The sensitivity of this subject for the various stakeholders shows clearly that the challenges are more than simply technical; there are fundamental social and economic interests at play. Veterinarians, food producers, researchers, or those appointed to committees and workgroups, face

the difficult and so far unanswered question: how can the Canadian agricultural sector – which is worth billions of dollars to the economy and employs tens of thousands of people – move beyond its dependence on antimicrobials?

The problem with existing policy approaches (whether provincial or federal) to addressing the public health challenge posed by antimicrobial resistance is that they involve a very narrow conceptualization of the relationship between antimicrobial use and society; as such, they ignore the broader and potentially conflicting social, economic and political interests of the various stakeholders. Policies have a tendency to be formulated by agricultural and public health agencies, with limited or even biased stakeholder consultations, as if the response to the problem of antimicrobial use in agriculture can be purely technical. Following the release of the report and recommendations of the Sous-groupe de travail sur l'antibiorésistance, in September 2008 the MAPAQ created a new working group, the Groupe de travail sur la prévention de l'antibiorésistance et l'utilisation judicieuse des antibiotiques, whose mandate is to establish priorities and develop an action plan that implements the Sous-groupe's initial recommendations. But once again, the priorities and recommendations of the new working group are essentially technocratic in nature, involving for example, the implementation of surveillance systems of antimicrobial usage and resistance development, or technical recommendations concerning “judicious or rational” usage of antimicrobials to be disseminated through veterinary education, guidelines for veterinarian use of antimicrobials, research, etc. There is little or no attention given to the social or economic realities faced by the veterinarians, food producers and food production companies who must implement these recommendations. (The composition of the working groups will be discussed in the following section).

Our contention, and one that is substantiated by decades of research in the field of Science and Technology Studies (STS), is that technologies necessarily incorporate particular social or moral values, and are socially and culturally embedded.<sup>33</sup> While it is clear that diminishing antimicrobial use in animal food production is an important public health goal that requires rational political decisions based on sound scientific data, risk assessment studies and other technical information, these decisions cannot be justified simply on scientific grounds or through technocratic processes. For a policy response to be effective, and more importantly for it to be acceptable and ulti-

mately accountable to the diversity of stakeholders, it must move beyond a narrow technocratic response. That is, policy makers should – whether through their own analyses, or through more direct stakeholder consultations – pay particular attention to the social, economic and moral values at stake, and the diverse and potentially conflicting interests of the range of stakeholders involved in the use of antimicrobials in agriculture. This is particularly important in the context of antimicrobial usage in hog and other food animal production, because any significant modification of current usage will imply major modifications to farm level management procedures, and ultimately even necessitate a complete re-thinking of modern animal production practices.

### THE SOCIAL CONTEXT OF VETERINARIAN PRACTICE

Antimicrobials are an essential means by which small family farms in North America and Europe evolved, in the 1950s and 1960s, into intensive, business-oriented food animal production facilities. Pork production followed a similar pattern of scaling-up, but then in the 1990s saw an exceptional intensification that is arguably a separate socioeconomic phenomena from scaling up. In Quebec, almost 50% of pork production is done by independent producers, and 50% by producers working under contract from integrated agribusinesses.<sup>34</sup>

The independent producer in general possesses the full range of goods necessary for the operation (including land, buildings, equipment and animals), and supplies are purchased from a variety of wholesalers. The contract producer owns land, buildings and equipment, but not the animals, which are supplied by the integrated agribusiness who are the owners of the animals and pay the producer for delivering grown animals for slaughter; the contract producer may also receive bonuses depending on levels of mortality and other quality measures. The integrated businesses combine within their operations many if not most of the elements involved in pork production, transformation and distribution – i.e., they own the piglets, equipment, feed, antimicrobials, finished hogs, processing and packaging – and so these companies are said to be “vertically integrated”. The marketing of hogs is also increasingly structured through collective pricing agreements to stabilise prices over the long term and also ensure that producers receive the same price per animal produced (e.g., in Quebec, pricing is fixed by the Assurance stabilisation des revenus agricoles de la Financière Agricole, ASRA). Given that the amount of income gen-

erated per pig is outside the control of producers, the only way to increase revenue is to reduce the costs of production.

These modern food production conditions are now dependant of antimicrobial use. Food animal production is a complex biological process linked to a complex management skill. It is no longer “farmers” who raise animals, but instead “food producers” who optimize the growth and production potential of food animals through the management of living environments, selection and modification of feed, selective scientific breeding for trait selection, etc. Production settings range from the relatively small family farm with hundreds of animals to large-scale operations with thousands or tens of thousands of animals. Important differences also exist between farms with regards to the animal species being raised, their geographical location, market conditions, production sizes, management methods, and the possibility of treating individual animals versus group treatment.

The optimization of growth and production also requires the optimization of the health of both individual animals as well as the herd or flock. Depending on whether a farm or “production facility” is confined (e.g., larger battery chicken facilities or hog farms that employ various levels of biosecurity) or non-confined facilities (e.g., “free-range” chickens or beef cattle ranches), they may use considerable or limited amounts of antimicrobial drugs. In large confined operations, there is a greater risk of disease spread across a population and thus a concomitant need for wide scale prophylactic treatment; free-range animals may also need prophylaxis given greater environmental exposure to microbes. However, as mentioned previously, with the exception of some organic food animal production, antimicrobials are also widely used for growth promotion across animal species (although at much lower concentrations), both in confined and non-confined operations. Food producers are thus major consumers of antimicrobial drugs, and it is veterinarians who prescribe them.

### *Professional Responsibilities*

Food animal veterinarians take a professional oath to promote and protect animal health and welfare, relieve animal suffering and protect public health regardless of the agricultural production setting. The Canadian Veterinary Medical Association (CVMA) is committed to excellence within the profession and to the well-being of animals, and while the Association does not have a specific code of ethics it



does have position statements on animal welfare.<sup>35</sup> The code of ethics of veterinarians in Quebec (Ordre des médecins vétérinaires du Québec, OMVQ) includes duties to the public, clients, the profession and animals.<sup>36</sup> The code focuses mainly on professional conduct in relation to clients and colleagues, with the interest of animals and public health being considered as implicit rather than being discussed explicitly.

The CVMA identifies antimicrobial residue prevention as a national issue that is “addressed by the CVMA on behalf of the profession”.<sup>37</sup> Guidelines on the Prudent Use of Antimicrobial Drugs in Swine have been approved by the CVMA; they concern antimicrobial usage for therapeutic treatment, control and prevention of bacterial disease. The CVMA guidelines specify that veterinarians should dispense and prescribe antimicrobials only within the confines of a valid veterinarian-client-patient relationship and that they should, for example in the case of pork production, use the Canadian Quality Assurance (CQA) program<sup>38</sup> of the Canadian Pork Council as a basis for the judicious use of antimicrobials.<sup>39</sup> As already mentioned, in Quebec, antimicrobials (including antimicrobial drugs used as growth promoters) are available only with a veterinary prescription and supervision, and are distributed exclusively by veterinarians and pharmacists. In the other Canadian provinces and in the US, antimicrobials are sold freely over the counter, and feed manufacturers prepare and sell medicated food to producers. This medicated food is used for treatment and prevention of specific diseases as well as for growth promotion. In Quebec, feed manufacturers must receive an appropriate veterinarian prescription from food producers, prior to selling their medicated animal feeds.

### Conflicts of Role and Interest

In the use and regulation of antimicrobials, food animal veterinarians are a key actor. This profession bridges and helps negotiate relations between the other stakeholders involved; that is, veterinarians stand between food producers (and animals) who are the end users of antimicrobials, the pharmaceutical industry which produces and sells these drugs, and agricultural and public health regulators seeking to control the use and limit the negative impact of antimicrobials (See Figure 1).

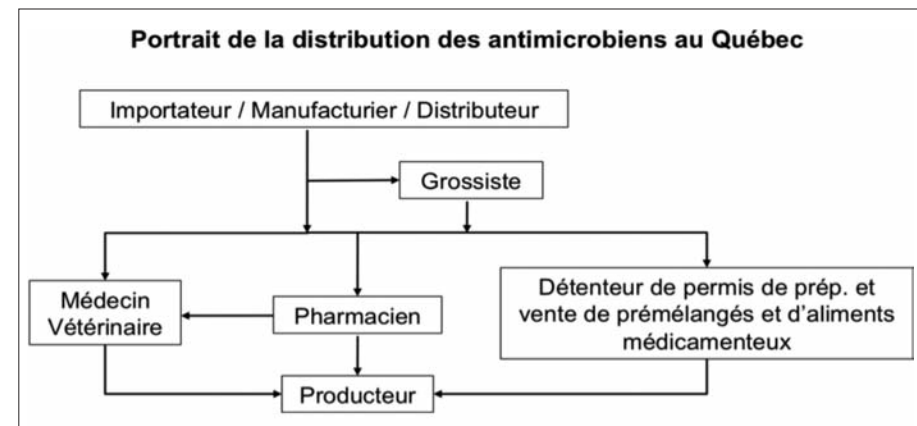


Figure 1. Adapted from Annex 1 of the report by the Sous-groupe de travail sur l'antibiorésistance / Groupe qualité. Avril 2006. *Distribution des antimicrobiens au Québec : Sources de collecte des données en continu*, Québec : MAPAQ, p. 24.

As already noted in the previous section, veterinarians have different responsibilities towards and relations with each of these stakeholders or interested parties. Veterinarians have the professional responsibility to limit their prescription of antimicrobials for public health reasons; in the various policy statements already discussed, vets are charged to prescribe only those drugs that are appropriate for managing the disease in question. Yet their clients, food producers, need antimicrobials for management use, and in Quebec, usually purchase these drugs directly from veterinarians, who in turn purchase them from the pharmaceutical industry or drug wholesalers; in other Canadian provinces, food producers may purchase antimicrobials directly from the pharmaceutical industry.

Being at the same time prescriber and vendor places food animal veterinarians in a difficult conflict of interest; they may and often do obtain a significant portion of their income from the sale of the antimicrobials they prescribe, and thus may have a strong financial interest in selling drugs that are contrary to other, e.g., public health, interests. This conflict, which is identical in the case of human health, has in many jurisdictions resulted in prohibitions or restrictions on physician referral practices; to avoid the financial conflict of interest, physicians may be prohibited from prescribing medications or

referring for services provided by clinics in which they are owners or partners.<sup>40</sup> At the same time, physicians – and by analogy, veterinarians – play an important role in managing the use of costly and potentially dangerous medications, thus the importance of requiring prescriptions for many medications (and not permitting over-the-counter sale). It is interesting, then, to question why such conflicts are still permitted by current Canadian agricultural regulations – and why prescriptions are not required in provinces other than Quebec – when such actions may undermine the safety of food production and threaten public health.

To further complicate matters for veterinarians, they face two other types of conflict between their professional obligations and their practical responsibilities, i.e., in their relationship with food producers and in the appropriate selection of antimicrobials. The aforementioned CVMA Guidelines on the Prudent Use of Antimicrobial Drugs in Swine require vets to prescribe antimicrobial drugs only within the confines of a valid veterinarian-client-patient relationship. Yet food animal production in Canada and internationally has evolved into large scale agribusiness, so the relationship between veterinarians and food producer has changed. The farmer/owner of animals is increasingly being replaced by the producer/owner of animals as economic units, and this has a direct impact on veterinary prescribing practices and the management of antimicrobial use. That is, veterinarians are asked to both prevent/treat animal illness and to support the growth promotion of animals, health and economic outcomes made possible by the use of antimicrobials; but then veterinarians are also asked to manage (and even limit) the use of antimicrobials in the name of public health.

In this context, veterinarians face important challenges in working with independent and contract producers, and also with vertically integrated agribusinesses. Vets are asked, even pressured, to prescribe antimicrobial drugs both for medical reasons (treatment, prophylaxis) and for growth promotion (use in food additives); and they have both professional and financial incentives to accommodate these requests. Yet their professional codes, and the recommendations of national and international guidelines, run counter to these demands. Vets are encouraged to properly select and use antimicrobial drugs, but due to the production methodology involved in contemporary agribusiness – i.e., large numbers of animals in the same

pen, and several pens in the same building – in many cases individual animal treatment is almost impossible, and not only for curative treatment but also for prevention and for metaphylaxis. As a result, veterinarians have no other choice than to prescribe large amounts of antimicrobial drugs, both for treatment and growth promotion.

These professional conflicts of interest and responsibility highlight the extent to which the prescription of antimicrobials is never a purely medical decision. Instead, prescription also invariably involves judgements that are influenced by a veterinarian's professional responsibilities to their patients (animals), their clients (food producers and food production companies), and to the general public (public health considerations). Some of these decisions may involve conflicts of interest, others may not; some of the conflicts may be avoidable or manageable, while others may be sufficiently serious that formal regulation or changes to practice and policy will be required. The point is that these various veterinarian interests, and their interrelation with the interests of producers and agribusinesses, are directly associated with the management of antimicrobial resistance.

### *Role in Policy Making*

As the primary prescribers of antimicrobials, food animal veterinarians can and should play a more important role in the creation of policies to control antimicrobial resistance. But veterinarians have the distinct impression that their concerns and interests are not taken into account in policy studies and eventual decision making.<sup>41</sup> As already discussed, in Quebec the MAPAQ created two working groups to address the issue of antibiotic resistance, and while these groups did include veterinarians as members, the resulting studies and reports have tended to be technocratic in nature. We suggest that this situation can in part be explained by the composition of these working groups, and specifically the issue of representation of *practicing* food animal veterinarians.

When the Sous-groupe de travail sur l'antibiorésistance submitted its report to the members of Association des vétérinaires en industrie animale (AVIA) in 2006, this produced a very strong reaction, not only against the contents of the report (which was perceived to have ignored practices already in place in the veterinary profession), but also because of a lack of effective representation

on the part of AVIA during the consultations about antimicrobial resistance.<sup>42</sup> While 7 veterinarians were members of this working group, they were for the most part scientists (e.g., epidemiologists, pathologists or microbiologists) and not practicing veterinarians. These veterinarians were from the Association québécoise des industries de nutrition animale et céréalière du Canada (1), the Public Health Agency of Canada (1), and the MAPAQ (3); there was only one member representing the AVIA and one from the Ordre des médecins vétérinaires du Québec (OMVQ). Interestingly, the membership of the Groupe de travail sur la prévention de l'antibiorésistance et l'utilisation judicieuse des antibiotiques (created in 2008), seems to be more politically correct; it now includes representatives from the full range of veterinarian stakeholders, that is, the OMVQ, AVIA, Académie des médecins vétérinaires du Québec, the Faculté de médecine vétérinaire at the Université de Montréal, MAPAQ, and the Public Health Agency of Canada. But will this broader representation of scientific and practicing veterinarians lead to more practical and politically acceptable recommendations, and importantly, will it address the important conflicts of interest at stake for veterinarians and other stakeholders?

There is a sense among many practicing veterinarians that the MAPAQ working groups are “re-inventing the wheel” while also restricting veterinary practice (e.g., requiring more detailed prescriptions, which while appropriate, is perceived as a further imposition). The recommendations of these working groups reflect the experiences and professional judgments of their members, which is not surprising; such is the nature of any working group. But in focusing on a review of the scientific literature, technical analyses, and quantitative studies of the use of antimicrobials, the impact of the working groups' recommendations on the daily practice of veterinarians have and continue to be ignored. It is important to also recognise that such techno-scientific approaches to dealing with the issue of antimicrobial resistance are widespread. Even the AVIA, for example, has argued that the number one priority is for Health Canada to conduct risk analyses related to the impact on human health of the use of antimicrobials in animals. AVIA is silent regarding concerns about the economic aspects of the use of antimicrobials (especially the financial pressures for food producers and food production companies), the conflicts of interest and responsibility facing veterinarians, or the need to more fully re-think current food animal management practices. So while the recommendations of the working groups arguably reflect a political willingness (from

government and professional associations) to reduce the use of antimicrobials – and there are some useful recommendations regarding improved monitoring and data collection – there has not been a concomitant willingness to seriously question the current practice of industrial food animal production in Canada.

## CONCLUSION

There is international, national and provincial consensus that, for public health reasons, the current practice of antimicrobial drug use in food animal production needs to be changed in order to reduce their misuse and overuse, and mitigate the important public health risks associated with antimicrobial resistance. For many years now, Canadian and Quebec public health and agricultural authorities have been working on this problem. Unfortunately, the guidelines put forward consist essentially of technocratic recommendations (such as surveillance programs, risk assessment studies), suffer from a lack of timeliness and transparency, and pay little attention to the underlying social and economic realities (and interests) of the various stakeholders involved, and in particular we argue, those of food animal veterinarians.

The issues associated with antimicrobial use in food animal production are complex. Agriculture in Canada is intensive, specialised, industrial (often vertically integrated), a major part of provincial and national economies, and operating in an international and highly competitive market. In the context of food animal production, antimicrobial drugs have become an essential management tool. The social and economic interests at stake are huge – for the agricultural sector, food producers and veterinarians, but also for consumers and politicians. For example, imagine that Canadian health and agricultural policy makers decided to prohibit the use of antimicrobials for growth promotion in food animals in the name of public health, as is the current practice in Europe. The negative consequences might well include increased production costs and thus more costly food, decreased competitiveness in relation to the American and Asian agricultural sectors, farm failures and a demand for subsidies and bailouts, and finally an off-shoring of agribusinesses. Even just one of these potential consequences would be a political “hot potato”. So it should not be surprising, then, that discussions about reducing or changing current practices provoke a high level of sensitivity, an obscuring of the positions of those involved in the policy making process, and create dis-

satisfaction on the part of many of those stakeholders most affected, namely veterinarians, food producers and food production companies. Any moves to make significant changes to antimicrobial use will likely require a complete rethinking of food animal production practices, something that seems unlikely in the current economic and political climate. Yet as we have shown, the public health reasons for reducing agriculture's reliance on antimicrobials are important. Where, then, is there any room for hope?

In Quebec, it is veterinarians who have the power to prescribe antimicrobials, and as such, they are important gatekeepers in regulating access to antimicrobial drugs; other provinces would be well advised to follow this lead in order to control access to and use of antimicrobials in food animal production. Yet critical attention must also be paid to the professional and economic interests at stake for food animal veterinarians, and the potential and real conflicts of interest that arise when vets prescribe antimicrobials. Lessons can and should be learned from moves to manage the conflicts of interest facing physicians (e.g., separating payment for treatment and prescription), so that they – and veterinarians – can meet their professional and ethical responsibilities towards their clients and patients. Broader public health policy to limit the use of antimicrobials in growth promotion is essential, but re-thinking the current reliance on antimicrobials remains a major challenge due to the important economic and political interests at stake. Developing such policy, we have argued, entails moving beyond the traditional reliance on techno-scientific analyses of antimicrobial risk and benefit, to more fully integrated reflection on the range of stakeholder interests and values at stake in contemporary agriculture.

We thank Catherine Olivier for her helpful comments on an early draft of this paper. Béatrice Doizé was supported by a contract from the Public Health Agency of Canada.



## NOTES

- 1 During slaughter and processing, 33-43% of live animal weight is removed and discarded as inedible waste. This includes fat, meat, viscera, bone, blood and feathers that are collected and processed to produce high quality proteins that have traditionally been used to feed animals, including herbivores. However, since the BSE crises, the use of bone meal has been prohibited. Cunningham, E.P., *After BSE: a future for the European livestock sector*, Wageningen, European Association for Animal Production, 2003, <[http://cms2.ibvision.nl/\\_clientFiles/%7B7E09414A-876D-45D3-9E9CD4BF7C1C6DD8%7D/more/EAAP108.pdf](http://cms2.ibvision.nl/_clientFiles/%7B7E09414A-876D-45D3-9E9CD4BF7C1C6DD8%7D/more/EAAP108.pdf)> accessed August 27 2009.
- 2 Héma-Québec, “Donor Qualification”, 2009, (updated January 16, 2009) <<http://www.hema-quebec.qc.ca/anglais/dondesang/qualifidonneurs.htm>> accessed March 11, 2009.
- 3 Klint Jensen, Karsten, “BSE in the UK: why the risk communication strategy failed”, *Journal of Agricultural and Environmental Ethics*, vol. 17, 2004, p. 405-423; Millstone, Erik and van Zwanenberg, Patrick, “The evolution of food safety-policy-making institutions in the UK, EU and Codex Alimentarius”, *Social Policy and Administration*, vol. 36, no. 6, 2002, p. 593-609.
- 4 EU regulations prohibit routine preventative vaccination against FMD (and other conditions) in member countries, in order to meet international trade rules for “countries free from foot-and-mouth disease without vaccination” and so avoid trade sanctions or import restrictions on food products. DEFRA, *The role of vaccination in a future outbreak of FMD*, London, UK Department for Environment, Food and Rural Affairs, 2004, <<http://www.defra.gov.uk/animalh/diseases/fmd/pdf/vaccinationscenarios.pdf>> accessed March 11, 2009.
- 5 Murphy-Lawless, Jo, “The impact of BSE and FMD on ethics and democratic process”, *Journal of Agricultural and Environmental Ethics*, vol. 17, no. 5, 2004, p. 385-403; Anthony, Raymond, “Risk communication, value judgments, and the public-policy maker relationship in a climate of public sensitivity toward animals: revisiting Britain’s foot and mouth crisis”, *Journal of Agricultural and Environmental Ethics*, vol. 17, no. 4-5, 2004, p. 363-383.
- 6 Harrison, S. and Mort, M., “Which champions, which people? Public and user involvement in health care as a technology of legitimization”, *Social Policy & Administration*, vol. 32, no. 1, 1998, p. 60-70; OECD, *Citizens as partners: OECD handbook on information, consultation and public participation in policy-making*, Paris, Organisation for Economic Co-operation and Development, 2001; Leroux, Therese, Hirtle, Marie, and Fortin, Louis Nicola, “An overview of public consultation mechanisms developed to address the ethical and social issues raised by biotechnology”, *Journal of Consumer Policy*, vol. 21, no. 4, 1998, p. 445-481.
- 7 Burgess, Michael M., “Public consultation in ethics: An experiment in representative ethics”, *Journal of Bioethical Inquiry*, vol. 1, no. 1, 2003, p. 4-13; Abelson, Julia et al., “Deliberations about deliberative methods: Issues in the design and evaluation of public participation processes”, *Social Science & Medicine*, vol. 57, no. 2, 2003, p. 239-251; Kelly, Susan E., “Public bioethics and publics: consensus, boundaries, and participation in biomedical science policy”, *Science, Technology & Human Values*, vol. 28, no. 3, 2003, p. 339.
- 8 According to the US Centers for Disease Control, ‘antimicrobials’ are a “general term for the drugs, chemicals, or other substances that either kill or slow the growth of microbes. Among the antimicrobial agents in use today are antibacterial drugs (which kill bacteria), antiviral agents (which kill viruses), antifungal agents (which kill fungi), and antiparasitic drugs (which kill parasites).” Similarly, ‘antimicrobial resistance’ involves “microbes changing in ways that reduce or eliminate the effectiveness of drugs, chemicals, or other agents to cure or prevent infections.” Centers for Disease Control, “Glossary on Antibiotic /Antimicrobial Resistance”, 2006, (updated March 29) <<http://www.cdc.gov/drugresistance/glossary.htm>> accessed October 30 2008.
- 9 Statistics Canada, *Hog Statistics, Third Quarter 2008*, Ottawa, Statistics Canada, 2009, <<http://www.statcan.gc.ca/pub/23-010-x/2008004/5801163-eng.htm>> accessed March 11, 2009.
- 10 European Commission, “Antibiotic resistance. Facts and figures. The importance of antibiotics”, 2001 <[http://ec.europa.eu/research/leaflets/antibiotics/page\\_32\\_en.html](http://ec.europa.eu/research/leaflets/antibiotics/page_32_en.html)> accessed March 11, 2009; Levy, Stuart B. and Marshall, Bonnie, “Antibacterial resistance worldwide: causes, challenges and responses”, *Nature Medicine*, vol. 10, no. 12 Suppl, 2004, p. S122-129; Alekshun, M. N. and Levy, S. B., “Commensals upon us”, *Biochemical pharmacology*, vol. 71, no. 7, 2006, p. 893-900.
- 11 World Health Organization, *WHO global principles for the containment of antimicrobial resistance in animals intended for food*, WHO/CDS/CSR/APH/2000.4, Geneva, WHO, 2000, <[http://whqlibdoc.who.int/hq/2000/WHO\\_CDS\\_CSR\\_APH\\_2000.4.pdf](http://whqlibdoc.who.int/hq/2000/WHO_CDS_CSR_APH_2000.4.pdf)> accessed March 11, 2009; World Health Organization, *WHO global strategy for the containment of antimicrobial resistance*, WHO/CDS/CSR/DRS/2001.2, Geneva, WHO, 2001 <[http://whqlibdoc.who.int/hq/2001/WHO\\_CDS\\_CSR\\_DRS\\_2001.2.pdf](http://whqlibdoc.who.int/hq/2001/WHO_CDS_CSR_DRS_2001.2.pdf)> accessed March 11, 2009; World Health Organization, *The medical impact of the use of antimicrobials in food animals. Report of a WHO meeting. Berlin, Germany, 13-17 October 1997*, WHO/EMC/ZOO/97.4, Geneva, WHO, 1997, <[http://whqlibdoc.who.int/hq/1997/WHO\\_EMC\\_ZOO\\_97.4.pdf](http://whqlibdoc.who.int/hq/1997/WHO_EMC_ZOO_97.4.pdf)> accessed March 11, 2009.
- 12 McCalla, Alex F., “FAO in the Changing Global Landscape”, *Department of Agricultural and Resource Economics, UCD. ARE Working Papers*, vol. Paper 07-006, 2007, <<http://repositories.cdlib.org/are/arewp/07-006>> accessed March 11, 2009.
- 13 Jukes, T. H., “Antibiotics in animal feeds and animal production”, *Bioscience*, vol. 22, 1972, p. 526-534.
- 14 Laval, A., “Produire du porc sans facteurs de croissance antibiotiques (antibiotiques régulateurs de flore ou AFR)”, *Colloque sur la production porcine* (Centre de référence en Agriculture du Québec, St-Hyacinthe, 2003).



- 15 Épidémio-Qualité Inc., *Étude sur l'usage actuel des antibiotiques en production porcine au Québec dans le groupe croissance-finition. Évaluation de l'utilisation des facteurs de croissance*, St-Hyacinthe, Qc, 2007, <[http://www.agrireseau.qc.ca/porc/documents/sommaire\\_ex%03%a9cutif\\_antibiotiques.pdf](http://www.agrireseau.qc.ca/porc/documents/sommaire_ex%03%a9cutif_antibiotiques.pdf)> accessed March 11, 2009.
- 16 Statistics Canada, *Hog Statistics, Third Quarter 2008*.
- 17 World Health Organization, *The medical impact of the use of antimicrobials in food animals. Report of a WHO meeting. Berlin, Germany, 13-17 October 1997*.
- 18 That is, bacteria that live in a symbiotic relationship with the organism.
- 19 Cohen, Mitchell L. and Tauxe, Robert V., "Drug-resistant Salmonella in the United States: an epidemiologic perspective", *Science*, vol. 234, no. 4779, 1986, p. 964-969; Bailar, J. C., 3rd and Travers, K., "Review of assessments of the human health risk associated with the use of antimicrobial agents in agriculture", *Clinical Infectious Diseases*, vol. 34 Suppl 3, 2002, p. S135-143; Travers, Karin and Barza, Michael, "Morbidity of infections caused by antimicrobial-resistant bacteria", *Clinical Infectious Diseases*, vol. 34 Suppl 3, 2002, p. S131-134.
- 20 UK Joint Committee of Houses of Parliament, *Report of the Joint Committee on the Use of Antibiotics in Animal Husbandry and Veterinary Medicine ("Swann Report")*, London, UK, Her Majesty's Stationary Office, 1969.
- 21 Van Houweling, C.D., "The food, drug, and cosmetic act, animal drugs, and the consumer", *Annals of the New York Academy of Sciences*, vol. 182, 1971, p. 411-415.
- 22 Spellberg, Brad et al., "Trends in antimicrobial drug development: implications for the future", *Clinical Infectious Diseases*, vol. 38, no. 9, 2004, p. 1279-1286; Wise, Richard, "The relentless rise of resistance?", *Journal of Antimicrobial Chemotherapy*, vol. 54, 2004, p. 306-310.
- 23 Olivier, Catherine et al., "Containing Global Antibiotic Resistance: Ethical Drug Promotion in the Developing World", in Sosa, A. et al. (eds.), *Antimicrobial Resistance in Developing Countries*, New York, NY, Springer, in press 2009; Aiello, Allison E., King, Nicholas B., and Foxman, B., "Ethical conflicts in public health research and practice: antimicrobial resistance and the ethics of drug development", *American Journal of Public Health*, vol. 96, no. 11, 2006, p. 1910-1914.
- 24 World Health Organization, *WHO global principles for the containment of antimicrobial resistance in animals intended for food*; Anthony, F. et al., "Antimicrobial resistance: responsible and prudent use of antimicrobial agents in veterinary medicine", *Revue scientifique et technique (International Office of Epizootics)*, vol. 20, no. 3, 2001, p. 829-839.
- 25 The motivation to develop these OFFS programs is linked to efforts to maintain the international competitiveness of Canadian agriculture. These programs are based on Hazard Analysis Critical Control Point (HACCP), an internationally accepted food safety assurance system. The Canadian Pork Quality Assurance (CQA) program is the producer component ([http://www.cqa-aqc.ca/program/materials\\_e.html](http://www.cqa-aqc.ca/program/materials_e.html)). Elements of the program include producers' operating manuals and the requirement for careful record keeping, traceability programs and auditing of the program on farms. The program is based on critical control points of good production practices, including medical supplies (use and storage).
- 26 Burkgren, Thomas and Vogel, Lyle, "Stakeholder position paper: food animal veterinarian", *Preventive Veterinary Medicine*, vol. 73, no. 2-3, 2006, p. 177-179.
- 27 Advisory Committee on Animal Use of Antimicrobials and Impact on Human Health, *Uses of antimicrobials in food animals in Canada: impact on resistance and human health*, Ottawa, Health Canada, 2002, <[http://www.hc-sc.gc.ca/dhp-mps/alt\\_formats/hpfb-dgpsa/pdf/pubs/amr-ram\\_final\\_report-rapport\\_06-27-eng.pdf](http://www.hc-sc.gc.ca/dhp-mps/alt_formats/hpfb-dgpsa/pdf/pubs/amr-ram_final_report-rapport_06-27-eng.pdf)> accessed March 11, 2009; Veterinary Drugs Directorate - Health Products and Food Branch, *Current thinking on risk management measures to address antimicrobial resistance associated with the use of antimicrobial agents in food-producing animals*, Ottawa, Health Canada, 2005, <[http://www.hc-sc.gc.ca/dhp-mps/vet/antimicrob/amr-ram\\_rep-rap\\_06\\_05\\_e.html](http://www.hc-sc.gc.ca/dhp-mps/vet/antimicrob/amr-ram_rep-rap_06_05_e.html)> accessed October 30 2008.
- 28 Veterinary Drugs Directorate - Health Products and Food Branch, *Current thinking on risk management measures to address antimicrobial resistance associated with the use of antimicrobial agents in food-producing animals*.
- 29 Canadian Veterinary Medical Association, "CVMA Guidelines for Prudent Use of Antimicrobial Drugs in Swine", 2002 <<http://canadianveterinarians.net/ShowText.aspx?ResourceID=84>> accessed March 11, 2009.
- 30 Épidémio-Qualité Inc., *Étude sur l'usage actuel des antibiotiques en production porcine au Québec dans le groupe croissance-finition. Évaluation de l'utilisation des facteurs de croissance*.
- 31 Edqvist, L.E. and Pedersen, K.B., *Antimicrobials as growth promoters: resistance to common sense*, European Environment agency, 2001; Casewell, M. et al., "The European ban on growth-promoting antibiotics and emerging consequences for human and animal health", *The Journal of Antimicrobial Chemotherapy*, vol. 52, no. 2, 2003, p. 159-161.
- 32 Personal experience of Dr. Doizé and colleagues.
- 33 Lehoux, Pascale, *The Problem of Health Technology: Policy Implications for Modern Health Care Systems*, New York, NY, Routledge, 2006.
- 34 Consultation publique sur le développement durable de la production porcine au Québec, *L'inscription de la production porcine dans le développement durable. Rapport d'enquête et d'audience publique.*, Québec, Gouvernement du Québec, 2003, <[http://www.bape.gouv.qc.ca/sections/rapports/publications/bape179\\_princ.pdf](http://www.bape.gouv.qc.ca/sections/rapports/publications/bape179_princ.pdf)> accessed October 30 2008.
- 35 Canadian Veterinary Medical Association, "Animal Welfare Position Statements", 2009 <<http://canadianveterinarians.net/publications-informations-position-animal.aspx>> accessed March 11, 2009.
- 36 Gouvernement du Québec, *Code de déontologie des médecins vétérinaires*, c. M-8, r.4.01, Québec, Publications du Québec, 2009, <<http://www.canlii.org/fr/qc/legis/regl/rq-c-m-8-r4.01/derniere/>> accessed March 11, 2009.
- 37 Canadian Veterinary Medical Association, "Our Priorities", 2009 <<http://canadianveterinarians.net/about-priorities.aspx>> accessed March 11, 2009.
- 38 [http://www.cqa-aqc.ca/program/materials\\_e.html](http://www.cqa-aqc.ca/program/materials_e.html)

- 39 Canadian Veterinary Medical Association, “CVMA Guidelines for Prudent Use of Antimicrobial Drugs in Swine”.
- 40 Kahn 3rd, Charles N., “Intolerable risk, irreparable harm: The legacy of physician-owned specialty hospitals”, *Health Affairs*, vol. 25, no. 1, 2006, p. 130-133; Tonelli, Mark R., “Conflict of interest in clinical practice”, *Chest*, vol. 132, no. 2, 2007, p. 664.
- 41 Observation made by Doizé at the Association des Vétérinaires en Industrie Animale (AVIA) meetings, and reply of the AVIA to the MAPAQ Sous-groupe de travail sur l’antibiorésistance recommendations.
- 42 Association des vétérinaires en industrie animale du Québec (AVIA), *Commentaires sur la proposition de moyens efficaces pour contrôler les facteurs associés au développement de la résistance microbienne, basés sur la réalité québécoise proposés par le MAPAQ*, St-Hyacinthe, 2007.